

Trimble Survey Controller™

User Guide



Trimble Survey Controller™

User Guide



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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

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About This Manual

Welcome to the world of surveying with the Trimble Survey Controller™ system. This system is a result of Trimble's continued commitment to manufacturing the very best survey products. The Trimble Survey Controller version 10.0 software operates on the Trimble System Controller platform, the TSCe™ data collector. Together they make it possible for you to survey more efficiently than ever before.

This manual is a complete reference guide, providing operating instructions for all Trimble Survey Controller functionality.

If you have had little or no exposure to surveying using Global Positioning System (GPS) products, the explanation of fundamental concepts is invaluable for learning and appreciating the issues that are important to conducting successful GPS surveys.

If you use conventional surveying instruments as well, the Trimble Survey Controller software lets you combine conventional observations with GPS observations in the same job. The Trimble Survey Controller software interfaces with all major brands of conventional instruments, including Trimble's own conventional total stations.

Even if you have used other Global Positioning System (GPS) products before, we recommend that you spend some time reading this manual to learn about the special features of this product.

If you are not familiar with GPS, visit our website at www.trimble.com for an interactive look at Trimble and GPS.

Related Information

As well as being supplied in hardcopy, this manual is available in portable document format (PDF) on the Trimble Survey Controller CD-ROM.

Other sources of related information are:

- The TSCe data collector has an online Help system that makes it easy to find the information you need. To access the Help system, press **[Alt] + [H]** or tap **Start** and select *Help*. If you are running the Trimble Survey Controller software, tap **[?]** or press **[Alt] + [H]** to access the Trimble Survey Controller Help.
- Release notes – the release notes describe new features of the product, information not included in the manuals, and any changes to the manuals. They are provided as a .pdf file on the CD
- <ftp.trimble.com> – use the Trimble FTP site to send files or to receive files such as software patches, utilities, service bulletins, and FAQs. Alternatively, access the FTP site from the Trimble website at www.trimble.com/support/support.htm.
- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, visit the Trimble website at www.trimble.com/support.

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- Send an e-mail to ReaderFeedback@trimble.com.
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If the reader comment form is not available, send comments and suggestions to the address in the front of this manual. Please mark them *Attention: Technical Publications Group*.

Document Conventions

The document conventions are as follows:

Convention	Definition
<i>Italics</i>	Identifies software menus, menu commands, dialog boxes, and the dialog box fields.
Helvetica Narrow	Represents messages printed on the screen.
Helvetica Bold	Identifies a software command button, or represents information that you must type in a software screen or window.
	Is an example of a hardware key (hard key) that you must press on the TSCe keypad.
	Is an example of a hardware function key that you must press on a personal computer (PC). If you must press more than one of these at the same time, this is represented by a plus sign, for example,  +  .
	Is an example of a softkey. The operation of softkeys is explained in the <i>Trimble Survey Controller User Guide</i> .

General Operation

In this chapter:

- Introduction
- Starting the Trimble Survey Controller software
- The Trimble Survey controller screen
- Entering data
- Reviewing the database
- File management

Introduction

This chapter describes how to operate the Trimble Survey Controller™ software.

The Trimble Survey Controller software simplifies surveying by configuring and controlling receivers for GPS surveys, and by communicating with conventional instruments for conventional surveys. The Trimble Survey Controller software:

- Stores points.
- Controls stakeout tasks.
- Performs numerous calculations, including Cogo functions.
- Permits two-way data transfer operations.

For GPS surveys it also:

- Configures the necessary receiver parameters.
- Monitors receiver and radio status.

The Trimble Survey Controller software makes surveying faster and more efficient. The best way to learn it is to take it out into the field and become familiar with the screen and keypad by pressing various keys, looking through the menus, and using the online help.

Starting the Trimble Survey Controller software

To start the Trimble Survey Controller software, do one of the following:

- Press + or tap  on the Windows task bar, then select *Programs / Survey Controller*.
- From the desktop, double-tap on the Survey Controller shortcut.

The Trimble Survey Controller Screen

This section describes the features of the Trimble Survey Controller screen and how to use them to operate the software. Figure 1.1 shows the parts of the screen.

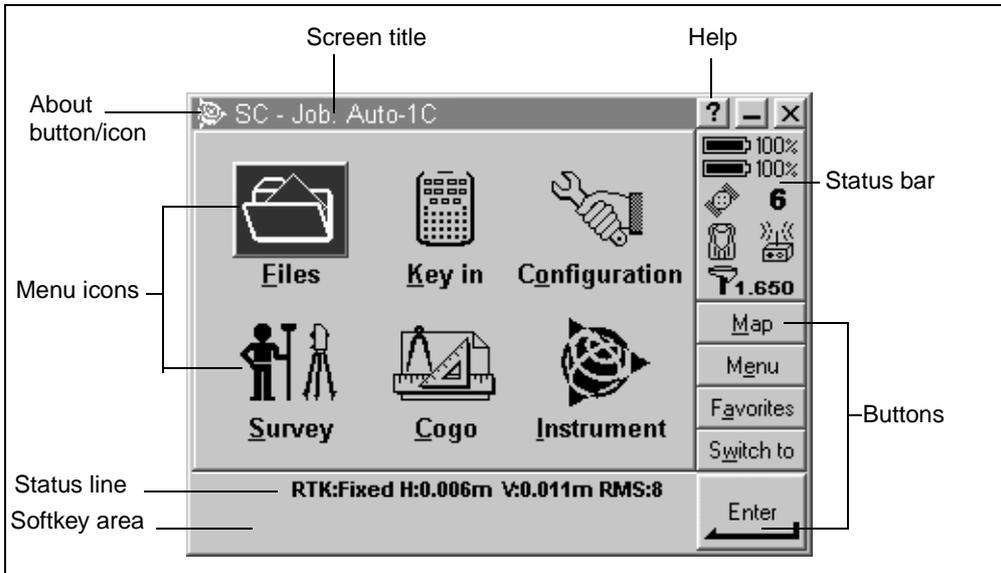


Figure 1.1 Typical Survey Controller screen



Tip – To view the description of a button/icon, tap and hold over the button/icon to display a ToolTip.

Menus

Menus list the Trimble Survey Controller software functions. When you turn on the TSCe data collector, the main menu appears after the Trimble logo screen.

To select a menu item, tap the required option.

Other menus, such as the *Files* menu or the *Instrument* menu, appear when you select these items from the main menu.

To return to the main menu at any time, tap **Menu**.

Figure 1.2 shows a two-page summary of the Trimble Survey Controller menu structure.

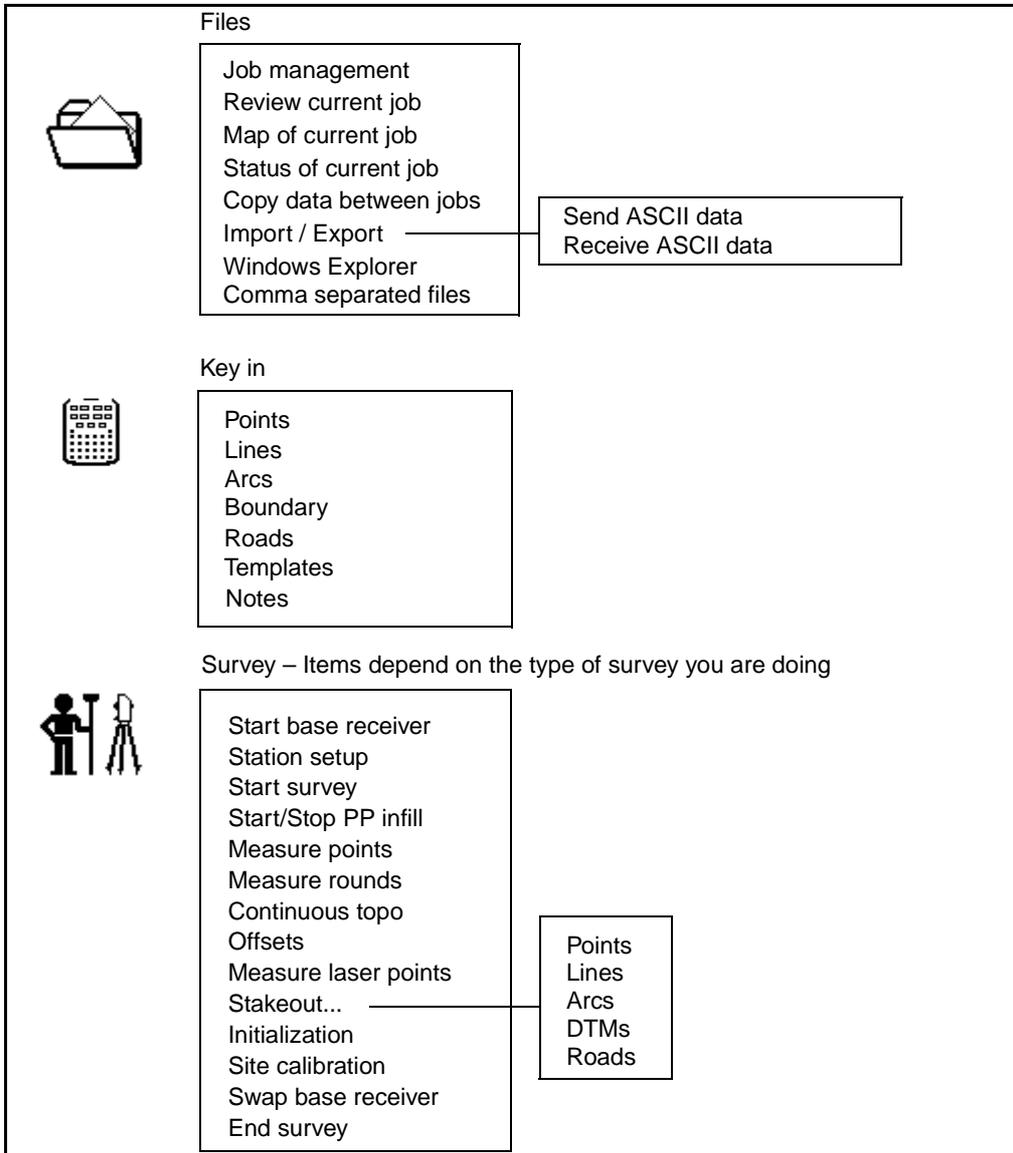
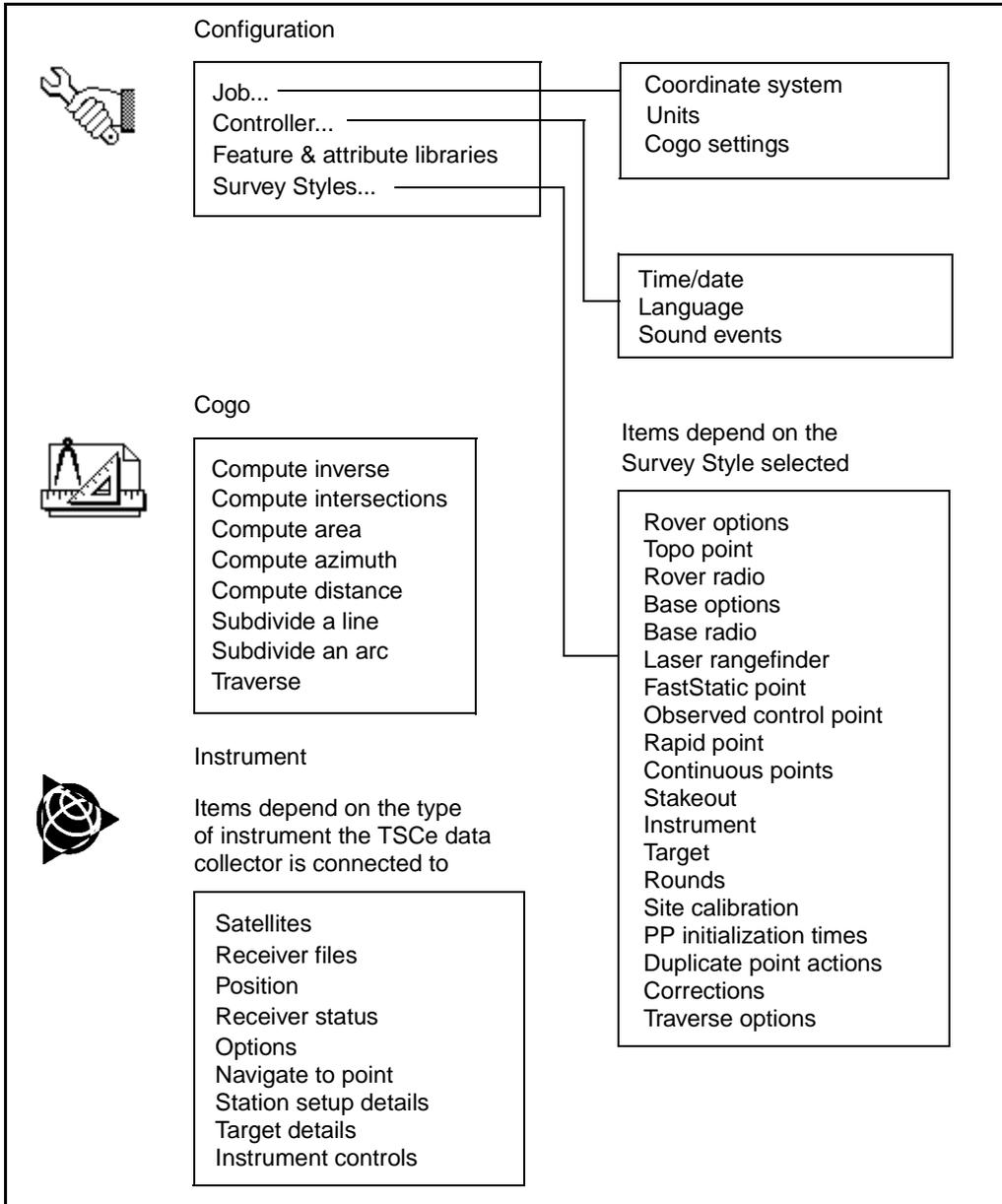


Figure 1.2 Trimble Survey Controller menu structure (continues next page)



Status Bar

The status bar is located on the right side of the Trimble Survey Controller screen. It displays various icons depending on the equipment that is connected to the TSCe data collector. Tap on an icon to view more information about the equipment. Table 1.1 lists and explains these icons.

Table 1.1 Status bar icons

Icon	What it shows
	Data collector is connected to and drawing power from an external supply.
	Data collector is connected to an external power supply and is recharging the internal battery.
 100% or  50%	Power level is 100%. or Power level is 50%. If this icon is on the top right, it refers to the TSCe internal battery. If it is below the internal battery, it refers to the power level of an external device.
	A GPS Total Station® 5700 receiver is in use.
	A GPS Total Station 4800 receiver is in use.
	A GPS Total Station 4700 receiver is in use.
	A GPS Total Station 4800 receiver is in use. The antenna height is shown to the right of the icon.

Table 1.1 Status bar icons (Continued)

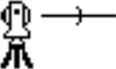
Icon	What it shows
	An external antenna is in use. The antenna height is shown to the right of the icon.
	A conventional instrument is in use. If a station setup is completed, the instrument height is shown to the right of the icon.
	A conventional instrument is being used to measure a point.
	A robotic instrument is locked on to the target (prism).
	A robotic instrument is being used to measure a point.
	The height of a conventional target is shown to the right of the icon.
	The prism is locked by the Robotic instrument. The target height is shown to the right of the icon.
	A static point is being measured.
	Radio signals are being received.
	Cellular modem signals are being received.

Table 1.1 Status bar icons (Continued)

Icon	What it shows
	WAAS signals are being received.
	Continuous points are being measured.
	If no survey is running, the number of satellites being tracked is shown to the right of the icon. If a survey is running, the number of satellites in the solution is shown to the right of the icon.

Map button

Tap  to display the map of the current job. For more information, see *Map of Current Job*, page 48.

Favorites menu

The *Favorites* menu provides quick access to commonly used screens (windows). You can access a screen from the Favorites list or use  to switch between active screens.

To access a screen from the Favorites list, tap  and select the screen that you want to access.

To add a screen to the Favorites list, view the screen you want to add and select *Favorites / Add to favorites*. To remove a screen, view the screen and select *Favorites / Remove from favorites*.

Enter button

The  button performs the same action as pressing  on the TSCe keypad. The action of the  button relates to particular screens, and in some screens, the caption on the button changes to describe the action for that screen. For example,  changes to  when you are in the *Measure points* screen.

Softkeys

Softkeys (software keys) are displayed on the bottom line of the Trimble Survey Controller screen. Softkeys relate to particular screens and only appear when these screens are accessed. For example, the  softkey appears when the *Antenna height* field is accessed, as it relates to this field.

Tap a softkey to access it, or use the shortcut key combinations with a designated key from the keypad. For example, in the Map of current job screen, to zoom in on an area, tap  or the key combination, +.

Note – The  softkey appears *if there are more than four softkeys associated with a screen. Tap it to see the others. Alternatively, press the  (Shift) key to access the other softkeys.*

Shortcut keys

Shortcut keys (also known as access keys or hotkeys) provide a quick way of using the keypad to access menus and commonly used options. They appear as an underlined letter in the menu or option description. Hold down the  key and press the appropriate letter key to use them.

Table 1.2 shows the shortcut keys that are commonly used in the Trimble Survey Controller software.

Table 1.2 Survey Controller shortcut keys

Use  plus this key...	to access the...
	Files menu
	Key in menu
	Survey menu
	Cogo menu
	Configuration menu
	Instrument menu
	Map of current job
	Main menu
	Favorites menu
	Switch to list
	Online Help

For information on the shortcut keys you can use to carry out commands in the TSCe data collector and Windows CE, see Appendix A, page 412.

Online Help

Online help for the Trimble Survey Controller software is displayed in Hyper-text Markup Language (HTML) pages. You can click on any underlined text (link) to move to the page it describes.

There are several ways to obtain help while you are using the Trimble Survey Controller software:

- To access help within the Trimble Survey Controller software, tap  or press  + .

An index of all the topics appears, with the default topic for the current screen highlighted. Do one of the following:

- To view this topic, tap the topic.
- To search for a different topic, enter a new keyword or scroll through the list.

Entering Data

To enter data:

1. When a field is highlighted, tap the field again to access it. Then do one of the following:
 - Type the numeric or alphanumeric details, depending on the field.
 - Select an item from a list of options. To do this, highlight the required option and tap .
 - Select an item from a list of relevant records in the database. To see the list of available records, tap , then select the required item(s) and tap . (The  softkey only appears when you edit certain fields.)
 - Select an item from the map. For more information, see *Selecting Features*, page 51.

- To enter a value in different units, type in the value and tap . Select the units to be used. The value is converted to the system units and the result is inserted in the field. For more information, see System Units, page 58.
- 2. When the field is complete, tap to save any changes and move to the next field.
- 3. When all fields are complete, tap to accept the screen. Some screens cannot be accepted unless certain fields have been completed. For example, in the *Measure points* screen, you cannot measure a point unless the *Point name* and *Antenna height* fields have values in them. If you tap before completing these fields, a warning message appears.

Using Quadrant Bearings

To enter quadrant bearings:

1. Make sure the system units are quadrant bearings. For more information, see System Units, page 58
2. Enter the bearing in any *Bearing* field.
3. Tap , , , or .

The quadrant bearing is inserted in the field.

Example

To enter the quadrant bearing N25° 30' 30"E in a bearing field:

- Key in 25.3030 .
- Tap .

Using the In-Field Calculator

The TSCe in-field calculator lets you calculate values for the following fields:

- Northing
- Easting
- Elevation
- Antenna height
- Azimuth
- Dist
- H.Dist
- V.Dist

When you access one of these fields, the **Operator** softkey appears, indicating that the calculator is available. Use the calculator to find values such as the total of two distances, or the distance between two points.



Tip – When calculating a distance between two points, tap **List** to select the points from the Trimble Survey Controller database.

Note – When keying in a point name that includes spaces, put double quotes around it. To save time, use the **List** softkey to select the point.

Table 1.3 shows the operators for the in-field calculator.

Table 1.3 Symbols used by the in-field calculator

Symbol	Function	Example	Result
=	Starting an equation	=3+4	7
+	Adding	=3+2+5	10
-	Subtracting	=5-3	2
*	Multiplying	=2*4	8

Table 1.3 Symbols used by the in-field calculator (Continued)

Symbol	Function	Example	Result
/	Dividing	=10/2	5
()	Inserting parentheses	=2*(5+3)	16
	Calculating the azimuth between two points	=1000  1001	Azimuth between Point 1000 and Point 1001 Note: The arrow symbol only appears in the list for an azimuth field.
	Calculating the slope distance between two points	=1000  1001	Slope distance between Point 1000 and Point 1001
	Calculating the horizontal distance between two points	=1000  1001	Horizontal distance between Point 1000 and Point 1001
	Calculating the vertical distance between two points	=1000  1001	Vertical distance between Point 1000 and Point 1001 Note: The triangle symbols only appear in the list for a distance field.



Tip – When you enter equations using the in-field calculator, enter the “=” symbol first.

Time/date options

To find out how to set the time and date on the TSCe data collector, see Appendix A, page 415. To specify other time and date options in the Trimble Survey Controller job, select *Configuration / Controller / Time/date* and do the following:

- Set the fixed interval after which the Trimble Survey Controller software automatically records the current time in the current job. Enter the required interval in the *Time stamp* field.

- Set the GPS time display to Local date/time if you want to display the GPS time (for example, in the QC records) as a local date and time instead of GPS weeks and seconds. The values are always stored as GPS weeks and seconds—this setting only configures the display.

Reviewing the Database

To view the records stored in the job database, do one of the following:

- From the main menu, select *Files / Review current job*.
- Tap **Favorites** and select *Review current job*.

Records are stored in chronological order.

To move around the database, use one of the following:

- The scroll bar.
- The **Page ↑** and **Page ↓** softkeys.
- The arrow keys.

To search for a particular item:

- Tap **Search**, and select an option to search for.

To move to the end of the database quickly:

- Highlight the first record then press **↑** on the keypad.

For more information about a record, highlight the record and tap **Enter**. The **Next** and **Prev** softkeys show the next record and the previous record respectively. Tap **Esc** to return to the database listing.

Note – If point coordinates appear as “?” see *Coordinate View Setting, page 16*.

You can edit certain records, for example, *Code* and *Antenna*.

Note – When you change an antenna height record in the database, any offset points that are stored as coordinates are not updated. Also, the change in antenna height does not affect any postprocessed points that will be processed using the Trimble Geomatics Office™ software. Verify the antenna height information when you transfer the data to the office computer. Do the same if you transfer postprocessed points directly from the receiver to the office software.



Tip – To review features from the *Map of current job* screen, select the required feature(s), tap and hold on the screen and choose *Review* from the shortcut menu.

You can store a note at any position in the database. To do this:

1. Highlight a record.
2. Tap . The *Note* screen appears.
3. Enter the note and tap . The note is stored immediately before the record you highlighted in step 1.

The *Note* screen remains open until you tap . Alternatively, tap when there is no text on the screen.

For details of the road information that is stored in a job, see Chapter 6, *Roading*.

Coordinate View Setting

The setting in the *Coordinate view* field (for example, WGS-84, Local, Grid, or HA VA SD) determines which values are visible in the point record. You can change the coordinate view setting for the job or just for viewing a point.

To change the coordinate view setting for the job, see *System Units*, page 58.

To change the *Coordinate view* setting for a point that you want to view:

1. When reviewing the database, highlight the point record and tap **Enter**.
2. Tap **Options** and set the *Coordinate view* field as required.

The options are listed in Table 3-4 on page 58.

If the coordinate value for a point is ?, one of the following situations may have occurred:

- The point may be stored as a GPS point but with the *Coordinate view* field set to *Local* or *Grid* and a datum transformation and projection not defined. To correct this, change the *Coordinate view* setting to *WGS-84*, define a datum transformation and/or projection, or calibrate the job.
- The point may be stored as a polar vector from a point which has been deleted. To correct this, restore the point.
- In a 2D survey, a projection may have been defined with the project height at null. To correct this, set the project height to approximate the site elevation.

Deleting and Restoring Points, Lines, or Arcs

To delete a point, line, or arc in the Trimble Survey Controller database:

1. From the main menu, select *Files / Review current job*.
2. Highlight the point, line, or arc to be deleted and tap **Enter**.
3. Tap **Delete**. For points, the search class changes to *Deleted (normal)*, *Deleted (control)*, *Deleted (staked)*, *Deleted (backsight)*, or *Deleted (check)*, depending on the original search classification.
4. Tap **Enter**. The Trimble Survey Controller software records a note after the original point, line, or arc record, showing the time it was deleted.

When you delete a point, line, or arc, the point symbol changes. For example, for a topo point, the  symbol replaces the \times symbol.

When you delete a face 1 or face 2 observation that contributes to a matched pair record, the matched pair record is also deleted. The same applies to mean turned angle records.



Tip – To delete features from the *Map of current job* screen, select the required feature(s), tap and hold on the screen and choose *Delete from* from the shortcut menu. Select the features you want to delete and tap .

To restore a point, line, or arc in the Trimble Survey Controller software database:

1. From the main menu select *Files / Review current job*.
2. Highlight the point, line, or arc to be restore and tap .
3. Tap .

Deleted points

A deleted point, line, or arc is not used in calculations, but it is still in the database. Deleting points, lines, or arcs does not make a job file smaller.

When you transfer a file that contains deleted points, the deleted points are not transferred to the office software. If you transfer a file using the Trimble™ Data Transfer utility, however, the deleted points are recorded in the Data Collector (.dc) file. They have a classification of Deleted.

Some points, such as continuous offset points and some intersection and offset points, are stored as vectors from a source point. If you delete a source point, any point stored as a vector from that point has null (?) coordinates when you review the database point record.



Tip – To see how a point is stored, select *Files / Review current job*. Then highlight the point, tap , and view the *Stored as* field. For more information, see Table 16.2 on page 301.

File Management

Use Microsoft Windows CE Explorer to view and manage (copy, delete/restore) files stored in the TSCe data collector. You can access Windows Explorer from the Trimble Survey Controller software. To do this, select *Files / Windows Explorer* from the main menu. The Windows Explorer screen opens at the \Trimble Data folder. This folder stores all job data used in Trimble software. The \Survey Controller folder stores the Trimble Survey Controller program and Help files.

Figure 1.3 shows the Trimble Survey Controller folder structure and the types of files located in each folder.

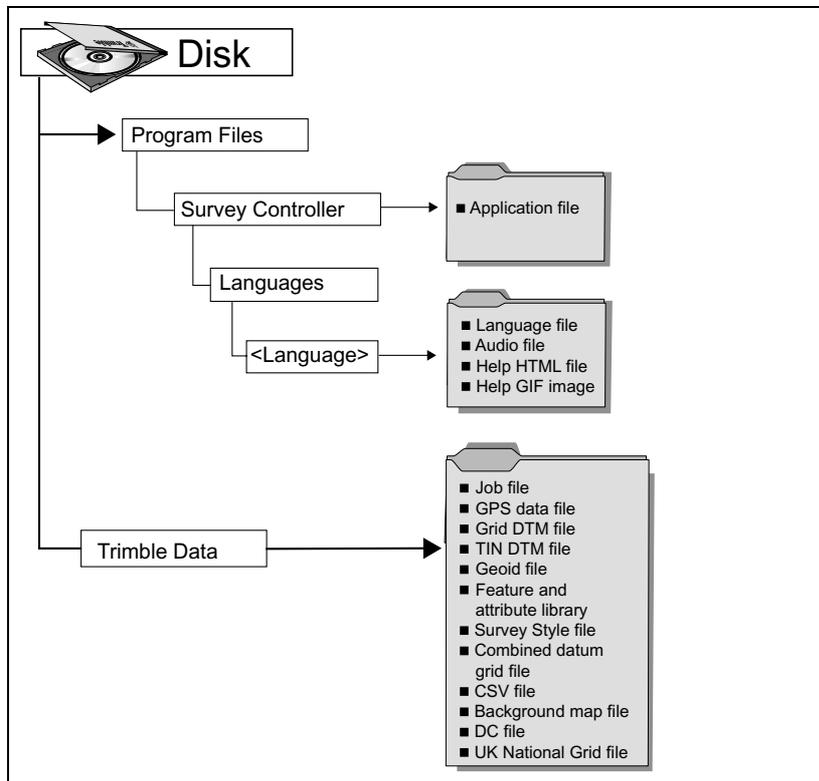


Figure 1.3 Trimble Survey Controller folder structure

For more information on using Windows Explorer, refer to the Windows CE Help provided on the data collector.



Tip – Use *Files / Job management* to copy and delete job files. If you delete job files, any associated GPS files associated are automatically deleted.

Messages

If the Trimble Survey Controller software cannot operate normally, it displays a message on the screen, or a flashing message in the status line. With some messages, the Trimble Survey Controller software makes an audible sound alerting you to the event that has occurred. For more information, see Sound Events, below.

Sound Events

Sound events are prerecorded messages that notify you about an event or action that has occurred. They correspond with status line messages, and common error and warning messages.

Sound events are stored as .wav files. You can customize your own sound events by replacing or deleting the existing .wav files located in the \Survey Controller\Languages\<Language>\ folder.



Tip – Use the Recorder application provided on the TSCe data collector to record your own sound events. Alternatively, transfer .wav files from the office computer to the TSCe data collector using Trimble's Data Transfer utility.

To turn sound events on or off:

1. From the main menu, select *Configuration / Controller / Sound events*.
2. Select the *Play sound events* check box to turn sound events on, or clear the check box to turn sound events off.

Status Line Messages

A status line message is usually displayed when the Trimble Survey Controller software cannot start or continue with its present function for some reason. For example, a message appears if there is no radio link or if the battery is low.

A status line message usually remains on the screen until you (or the Trimble Survey Controller software) resolve the situation.

When the TSCe data collector is connected to a receiver, the status line displays the current survey mode. Table 1.4 explains these modes.

Table 1.4 GPS status line mode display

Survey mode	Explanation
No Survey	The receiver is connected but a survey has not been started.
RTK:Fixed	The current RTK survey is initialized, and the solution type is L1 fixed—centimeter-level.
RTK:Float	The current RTK survey is not initialized, and the solution type is L1 float.
RTK:Check	The current RTK survey is verifying the initialization.
RTK:Auto	The radio link is down in the current RTK survey, and the solution is an autonomous position.
RTK:WAAS	The radio link is down in the current RTK survey, and the solution is a WAAS position
FastStatic	The current survey type is FastStatic.
PPK:Fixed	The current postprocessed kinematic survey is initialized and, when postprocessed, should yield an L1 fixed or an iono-free (centimeter-level) solution.
PPK:Float	The current postprocessed kinematic survey is not initialized and, when postprocessed, should yield an L1 float solution.
RT differential	The current survey type is real-time differential.
Infill:Fixed	The current kinematic infill survey is initialized and, when postprocessed, should yield an L1 fixed or an iono-free (centimeter-level) solution.

Table 1.4 GPS status line mode display (Continued)

Survey mode	Explanation
Infill:Float	The current kinematic infill survey is not initialized and, when postprocessed, should yield an L1 float solution.
Infill	The current survey type is differential, and you are doing an infill session.
WAAS	The current survey type is differential, and using signals from the WAAS satellites.

The root mean square (RMS) indicator is displayed when you are in Fine mode in a real-time kinematic survey. It shows the RMS of the current position, expressed in millicycles.

Coordinate Systems

In this chapter:

- Introduction
- GPS coordinate system
- Local coordinate systems
- Calibration
- Using a datum grid file
- Using a geoid model
- Working with ground coordinates
- Choosing a coordinate system for a GPS survey
- Choosing a coordinate system for a conventional survey

Introduction

Before starting a GPS survey, decide which coordinate system to use. This chapter discusses some things to consider when making this decision.

If you intend to combine conventional observations with GPS measurements, read the whole of this chapter. To make only conventional observations, see *Choosing a Coordinate System for a Conventional Survey*, page 39.

GPS Coordinate System

GPS measurements are referenced to the 1984 World Geodetic System reference ellipsoid, known as WGS-84. However, for most survey tasks, results in terms of WGS-84 have little value. It is better to display and store results in terms of a local coordinate system. Before you start a survey, choose a coordinate system. Depending on the requirements of the survey, you can choose to give the results in the national coordinate system, a local coordinate grid system, or as local geodetic coordinates.

When you have chosen a coordinate system, search your survey archives for any horizontal and vertical control points in that coordinate system that are in the area to be surveyed. You can use these to calibrate a GPS survey. For more information, see *Calibration*, page 271.

Local Coordinate Systems

A local coordinate system simply transforms measurements from a curved surface (the earth) onto a flat surface (a map or plan). Four important elements constitute a local coordinate system:

- local datum
- datum transformation
- map projection
- calibration (horizontal and vertical adjustments)

When you survey using GPS, consider each of these.

Local Datum

Because an exact model of the earth's surface cannot be created mathematically, localized ellipsoids (mathematical surfaces) have been derived to best represent specific areas. These ellipsoids are sometimes referred to as local datums. NAD83, GRS80, and AGD66 are examples of local datums.

Datum Transformation

GPS is based on the WGS-84 ellipsoid, which is sized and positioned to best represent the entire earth.

To survey in a local coordinate system, the WGS-84 GPS positions must first be transformed onto the local ellipsoid using a datum transformation. Three types of datum transformation are commonly used. Alternatively, you can choose not to use a transformation at all.

The datum transformations are as follows:

- three-parameter – This assumes that the rotational axis of the local datum is parallel with the rotational axis of WGS-84. The three-parameter transformation involves three simple translations in *X*, *Y*, and *Z*. The three-parameter transformation that the Trimble Survey Controller software uses is a Molodensky transformation, so there may also be a change in ellipsoid radius and flattening.

Note – Positions on a local datum are commonly called “local geodetic coordinates”. The Trimble Survey Controller software abbreviates this to “Local”.

- seven-parameter – This is the most complex transformation. It applies translations **and** rotations in *X*, *Y*, and *Z* as well as a scale factor.
- datum grid – This uses a gridded data set of standard datum shifts. By interpolation, it provides an estimated value for a datum transformation at any point on that grid. The accuracy of a datum grid depends on the accuracy of the gridded data set it uses. For more information, see Using a Datum Grid File, page 32.

Map Projection

Local geodetic coordinates are transformed into local grid coordinates using a map projection (a mathematical model). Transverse Mercator and Lambert are examples of common map projections.

Note – Positions on a map projection are commonly called “local grid coordinates”. The Trimble Survey Controller software abbreviates this to “Grid”.

Horizontal and Vertical Adjustments

If published datum transformation parameters are used, slight discrepancies can exist between local control and GPS-derived coordinates. These discrepancies can be reduced using minor adjustments. The Trimble Survey Controller software calculates these adjustments when you use the *Site calibration* function. They are called horizontal and vertical adjustments.

Calibration

Calibration is the process of adjusting projected (grid) coordinates to fit the local control. You can key in a calibration, or let the Trimble Survey Controller software calculate it. You should calculate and apply a calibration before:

- staking out points
- computing offset or intersection points

The rest of this section describes how to perform a calibration using the Trimble Survey Controller software. To key in a calibration, see *Creating a Job*, page 42.

Calibration Calculations

Use the Trimble Survey Controller software system to perform a calibration in one of two ways. Each method results in the computation of different components, but the overall result is the same if enough reliable control points (coordinates in your local system) are used. The two methods are:

- If you use published datum transformation parameters and map projection details when creating a job, and if you provide enough control points, the Trimble Survey Controller software performs a calibration that computes horizontal and vertical adjustments. Horizontal control points allow scale error anomalies in the map projection to be removed. Vertical control allows local ellipsoid heights to be transformed into useful orthometric heights.



Tip – Always use published parameters if they exist.

- If you do not know the map projection and datum transformation parameters when creating the job and defining the local coordinate system, specify *No projection/no datum*.
Then specify whether grid or ground coordinates are required after a site calibration. When ground coordinates are required, you must specify the project height. In this case, the Trimble Survey Controller software performs a calibration that calculates a Transverse Mercator projection and a Molodensky three-parameter datum transformation using the supplied control points. The project height is used to compute a ground scale factor for the projection so that ground coordinates are computed at that height.

Table 2.1 shows the output of a calibration when various data is supplied.

Table 2.1 Calibration output

Projection	Datum transformation	Calibration output
Yes	Yes	Horizontal and vertical adjustment
Yes	No	Datum transformation, horizontal and vertical adjustment
No	Yes	Transverse Mercator projection, horizontal and vertical adjustment
No	No	Transverse Mercator projection, zero datum transformation, horizontal and vertical adjustment

Local Control for Calibration

Trimble recommends that you observe and use a minimum of four local control points for the calibration calculation. For best results, local control points should be evenly distributed over the job area as well as extending beyond the perimeter of the site (assuming that the control is free of errors).



Tip – Apply the same principles as you would when placing control for photogrammetric jobs. Make sure that the local control points are evenly distributed to the extent of the job area.

Why Calibrations Are Needed

If you calibrate a project and then survey in real time, the Trimble Survey Controller software gives real-time solutions in terms of the local coordinate system and control points.

Operations That Require Calibration

Note – Perform a calibration at any time, but always complete the calibration **before** staking out any points, or computing offset or intersection points.

If no datum and no projection are defined, you can only stake out lines and points that have WGS-84 coordinates. Displayed bearings and distances are in terms of WGS-84.

Specify a projection before staking out arcs, roads, and DTMs. The Trimble Survey Controller software does not assume that WGS-84 is the local ellipsoid, so you must also define a datum.

Without a datum transformation, you can only start a real-time base survey with a WGS-84 point.

For information on how to perform a calibration, see Calibration, page 271.

Figure 2.1 shows the order of calculations performed when a calibration is calculated.

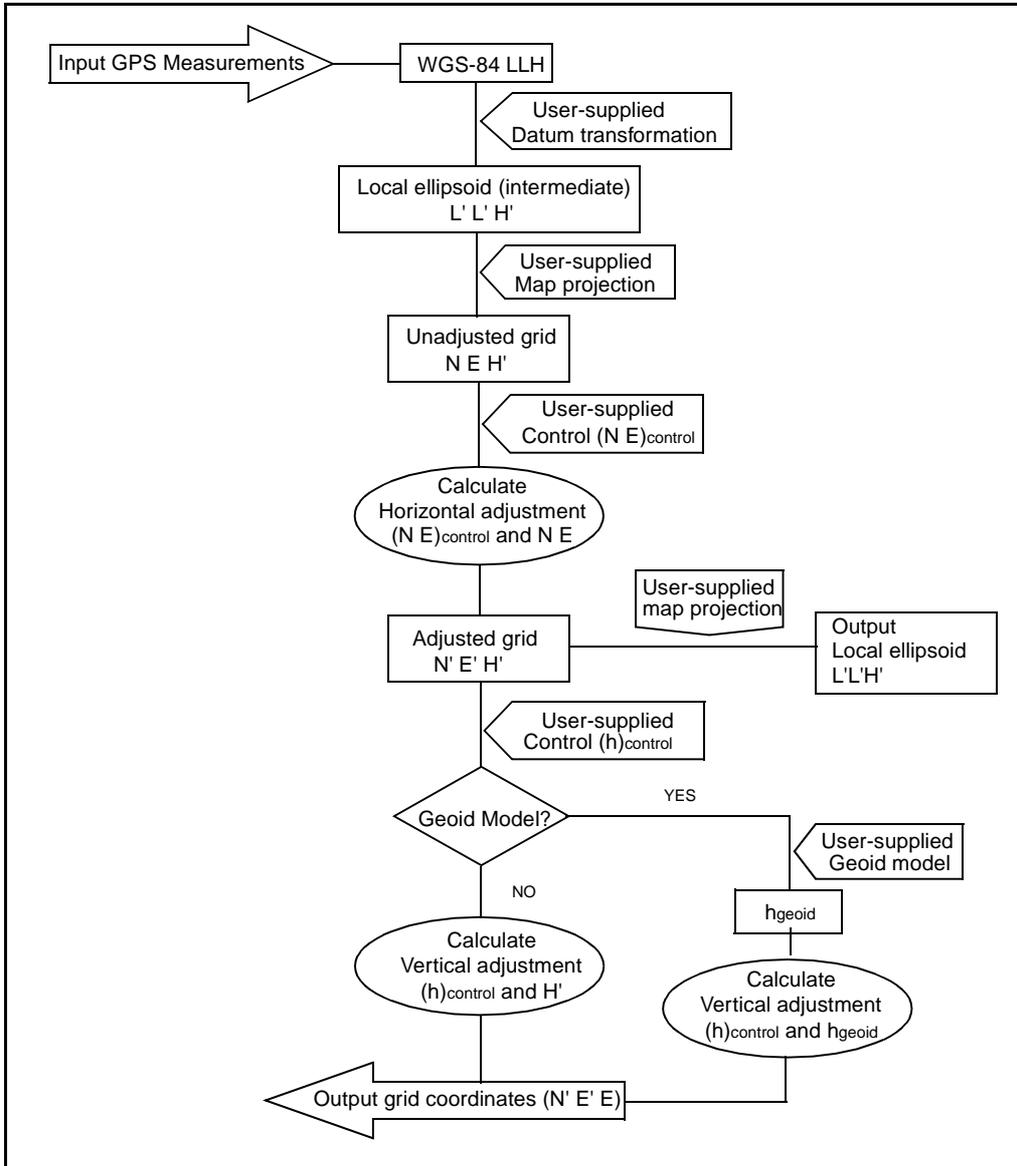


Figure 2.1 Calibration calculation process

Copying Calibrations

You can copy a calibration from a previous job if the new job is completely encompassed by that initial calibration. If a portion of the new job lies outside the initial project area, introduce additional control to cover the unknown area. Survey these new points and compute a new calibration. Use this as the calibration for the job.

Using a Datum Grid File

A datum grid transformation uses interpolative methods to estimate the value of the datum transformation at any point in the area covered by the datum grid files. Two gridded datum files are required for this interpolation—a latitude datum grid file and a longitude datum grid file. When you export a datum grid using the Trimble Geomatics Office software, the two datum grid files associated with the current project are combined into a single file for use in the Trimble Survey Controller software.

Selecting a Datum Grid File

To select a datum grid file when creating a job, do one of the following:

- Select a coordinate system from the library provided in the Trimble Survey Controller software. Select the *Use datum grid* check box. In the *Datum grid* field, select the file that you want to use.
- Key in the coordinate system parameters. Select *Datum transformation* and set the *Type* field to Datum grid. In the *Datum grid* field, select the file that you want to use.

Note – *The U.S. State Plane 1927 and the U.S. State Plane 1983 coordinate systems in the Trimble Survey Controller software use three-parameter transformations.*

To select a datum grid file for use in the current job:

1. From the main menu, select *Configuration / Job / Coordinate system*.
2. Do one of the following:
 - If the *Key in parameters* screen appears, select *Datum transformation* and set the *Type* field to Datum grid. In the *Datum grid* field, select the file that you want to use.
 - If the *Select coordinate system* screen appears, select the *Use datum grid* check box. In the *Datum grid* field, select the file that you want to use.

The semi-major axis and flattening values for the selected datum grid file are displayed. These details overwrite any already provided by a specified projection.

Using a Geoid Model

The geoid is a surface of constant gravitational potential that approximates mean sea level. A geoid model or Geoid Grid file (*.ggf) is a table of geoid-ellipsoid separations that is used with the GPS ellipsoid height observations to provide an estimate of elevation.

The geoid-ellipsoid separation value (N) is obtained from the geoid model and is subtracted from the ellipsoid height (H) for a particular point. The elevation (h) of the point above mean sea level (the geoid) is the result. This is illustrated in Figure 2.2.

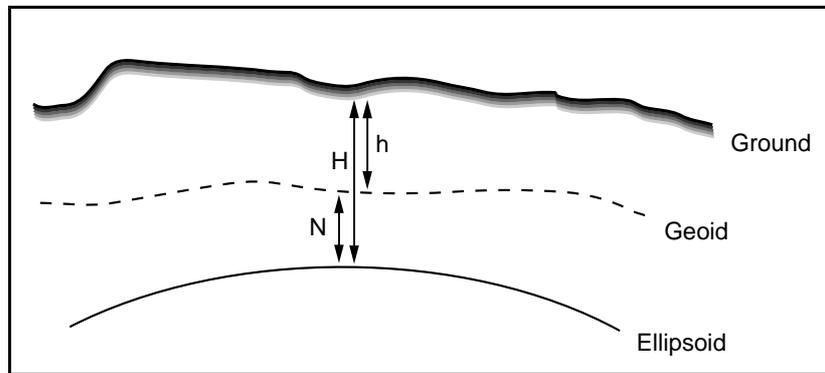


Figure 2.2 Geoid – ellipsoid separation

Note – For correct results, the ellipsoid height (H) must be based on the WGS-84 ellipsoid.

When you select geoid model as the vertical adjustment type, the Trimble Survey Controller software takes the geoid-ellipsoid separations from the geoid file chosen, and uses them to display elevations on the screen.

The benefit of this function is that you can display elevations without having to calibrate on elevation benchmarks. This is useful when local control or benchmarks are not available, as it makes it possible to work “on the ground” rather than on the ellipsoid.

Note – If you are using a geoid model in a Trimble Geomatics Office project, make sure you transfer that geoid file (or the relevant part of it) when transferring the job into the TSCe data collector.

Selecting a Geoid File

To select a geoid file when creating a job, do one of the following:

- Select a coordinate system from the library provided in the Trimble Survey Controller software. Select the *Use geoid model* check box. In the *Geoid model* field, select the file to be used.
- Key in the coordinate system parameters. Select *Vertical adjustment* and set the *Type* field to *Geoid model* or *Geoid/Inclined plane* as required. (Select *Geoid/Inclined plane* if you intend to key in the inclined plane adjustment parameters.)

To select a geoid file for the current job:

1. From the main menu select *Configuration / Job / Coordinate system*.
2. Do one of the following:
 - If the *Key in parameters* screen is displayed, select *Vertical adjustment* and set the *Type* field to *Geoid model* or *Geoid/Inclined plane* as required. (Select *Geoid/Inclined plane*, if you intend to key in the inclined plane adjustment parameters.)
 - If the *Select coordinate system* screen is displayed, select the *Use geoid model* check box. In the *Geoid model* field, select the file to be used.

Working with Ground Coordinates

If you need coordinates to be at ground level instead of projection level (for example, in areas of high elevation), use a ground coordinate system.

When you select a ground coordinate system, grid distances equal ground distances.

Setting up a Ground Coordinate System

When you set up a ground coordinate system in a Trimble Survey Controller job, the software applies a ground scale factor to the coordinate system projection definition.

To set up a ground coordinate system when creating a job:

1. Define the coordinate system for the job. Do one of the following:
 - Choose the *Select from library* option to select a coordinate system from the library provided in the Trimble Survey Controller software. Tap .
 - Choose the *Key in parameters* option to key in the coordinate system parameters. Tap and select *Projection*.
2. In the *Coordinates* field, choose an option to define the ground scale factor.

Additional fields appear below the *Coordinates* field.
3. If you select the *Ground (keyed in scale factor)* option, enter a value in the *Ground scale factor* field.
4. In the *Project location* group, enter values in the fields as required. Tap to enter the current autonomous position derived by the GPS receiver. The autonomous position is displayed in terms of WGS-84.

The project height is used with 2D points to reduce ground distances in Cogo calculations. For more information, see *Project Height*, page 66.

If you select the *Ground (calculated scale factor)* option, the fields are used to calculate the ground scale factor. When the fields are completed, the computed ground scale factor is displayed in the *Ground scale factor* field.

5. To add offsets to the coordinates, enter a value in the *False northing offset* and *False easting offset* field, as required.

Note – Use offsets to differentiate ground coordinates from unmodified grid coordinates.

To configure a ground coordinate system for the current job:

1. From the main menu, select *Configuration / Job / Coordinate system*.
2. Do one of the following:
 - If the *Key in parameters* screen is displayed, select *Projection* and select an option from the *Coordinates* field. Complete the fields below as required.
 - If the *Select coordinate system* screen is displayed, select an option from the *Coordinates* field and complete the fields below as required.

Choosing a Coordinate System for a GPS Survey

When you create a new job, the Trimble Survey Controller software prompts you to define the coordinate system you are using. You can select a system from the library, key in the parameters, select *Scale factor only*, copy a system from another job, or select no projection and no datum transformation. For more information, see *Creating a Job*, page 42.

The most rigorous coordinate system consists of four parts:

- datum transformation
- map projection
- horizontal adjustment
- vertical adjustment

Note – *To conduct a real-time survey in terms of local grid coordinates, define the datum transformation and map projection before starting the survey.*



Tip – In the *Coordinate view* field, select *Local* to display local geodetic coordinates. Select *Grid* to display local grid coordinates.

When WGS-84 coordinates are transformed onto the local ellipsoid, using a datum transformation, local geodetic coordinates result. Local geodetic coordinates are transformed into local grid coordinates using the map projection. The result is Northing and Easting coordinates on the local grid. If a horizontal adjustment is defined, it is applied next, followed by the vertical adjustment.

Choosing a Coordinate System for a Conventional Survey

When surveying using conventional equipment, it is important to choose a suitable coordinate system.

For example, if a job is to combine GPS measurements with conventional observations, choose a coordinate system that lets you view GPS observations as grid points. This means that you must define a projection and a datum transformation. For more information, see *Creating a Job*, page 42.

Note – You can complete the field work for a combined survey without defining a projection and a datum transformation, but you will not be able to view the GPS observations as grid coordinates.

If you want to combine GPS measurements with two-dimensional conventional observations, specify a project height for the job. For more information, see *Project Height*, page 66.

If a job is to contain conventional observations only, select one of the following when you create the job:

- A typical coordinate system and zone that provide mapping plane coordinates. For example, State Plane coordinates.
- Scale factor only.

In a conventional survey, measurements are made at ground level. To compute coordinates for these measurements, observations are reduced to grid level. The specified scale factor is applied to measured distances to reduce them from ground to grid.

The *Scale factor only* option is useful for areas that use a local scale factor to reduce distances to grid.



Tip – If you are not sure what coordinate system to use, select the *Scale factor only* projection and enter a scale factor of 1.000.

Job Operations

In this chapter:

- Introduction
- Job management
- Reviewing the job database
- Map of current job
- Status of current job
- Selecting comma delimited (.csv) files
- System units
- System settings and corrections

Introduction

Before starting a survey, select or create a job. All subsequent settings and data are stored in this job.

Note – In the Trimble Survey Controller software, GPS and conventional data can be combined in a single job.

You can change certain settings (such as the units and distance display) at any time. Trimble recommends that you set these before creating a job, as this reduces the number of records in the job database. For more information, see *System Settings and Corrections*, page 60.

Job Management

You can create, open, copy, delete, and close jobs in the Trimble Survey Controller database. The current job name is displayed at the top of the main menu. In addition, tap and hold on the title bar in the current screen to display a ToolTip of the job name.

To perform most job operations, select *Files* from the main menu. Then select *Job management*.

Creating a Job

To create a job:

1. Tap .

The *New job* screen appears.

2. Enter the job name in the *Name* field.
3. In the *Select coordinate system* field, select a coordinate system option. See *Selecting a Coordinate System*, below. Tap .

Selecting a Coordinate System

When you create a job, select a coordinate system using one of the following options:

- Select from library
- Key in parameters
- Scale factor only
- Copy from other job
- No projection/no datum

If a survey is to contain conventional observations only, select *Scale factor only*. If conventional observations are to be combined with GPS measurements, choose a coordinate system now. For more information, see *Choosing a Coordinate System for a GPS Survey*, page 38.

If you are not sure of the coordinate system, select *No projection/no datum*. You can define the values later in the job and then all points will be updated. (To do this, select *Configuration / Job / Coordinate system*. Tap or and enter the parameters or select a coordinate system.)

Note – *If you are using GPS, define the coordinate system and/or calibration for the job before computing offsets and/or intersection points, or staking out points.*

If you later change the coordinate system or calibration, any of the above points that are already computed, measured, or staked out will be inconsistent with the new coordinate system, and any points computed or staked out after the change.

Select from library

To select a coordinate system and zone from the list provided by the Trimble Survey Controller software:

1. In the *New job* dialog, choose the *Select from library* option.
2. Tap . The *Select coordinate system* screen appears.

3. Select the appropriate coordinate system and zone for the area.
4. To use a geoid file from the database, select the *Use geoid model* check box and set the *Geoid model* field to the geoid file name. For more information, see *Using a Geoid Model*, page 34.
5. To use a datum grid file from the database, select the *Use datum grid* check box and set the *Datum grid* field to the datum grid file name. For more information, see *Using a Datum Grid File*, page 32.
6. To use ground coordinates for the job, select an option from the *Coordinates* field and complete the fields below as required. For more information, see *Working with Ground Coordinates*, page 36.
7. The project height is used with 2D points to reduce ground distances in Cogo calculations. For more information, see *Project Height*, page 66.

Key in parameters

To key in the projection and datum transformation parameters for the site:

1. In the *New job* screen, choose *Key in parameters*. Tap .
The *Key in parameters* screen appears.
2. Select *Projection*, and enter the details for the site.
3. To use ground coordinates for the job, select an option from the *Coordinates* field and complete the fields as required. For more information, see *Working with Ground Coordinates*, page 36.
4. The project height is used with 2D points to reduce ground distances in Cogo calculations. For more information, see *Project Height*, page 66.
5. Select *Datum transformation*, and enter the appropriate parameters.

Note – When keying in the coordinate system parameters, define the local ellipsoid in either the *Projection* screen or the *Datum* transformation screen. If the values change in one of these screens, the Trimble Survey Controller software automatically changes them in the other.
The source ellipsoid is always WGS-84. The parameters do not appear here and there is no need to edit them.

Scale factor only

To select a Scale factor only coordinate system:

1. In the *New job* screen, choose *Scale factor only*. Tap .
The *Projection* screen appears.
2. Enter a value in the *Scale factor* field.

All distances measured with a conventional instrument are scaled by this value.

Copy from other job

To copy a coordinate system from another job in the database:

1. In the *New job* screen, choose *Copy from other job*. Tap .
2. Select the job name that you want to copy from.

No projection/no datum

To select a coordinate system with an undefined projection and datum:

1. In the *New job* screen, choose *No projection/no datum*. Tap . The *No projection/no datum* screen appears.
2. Set the *Coordinates* field to *Ground*, and enter a value (average site height) in the *Project height* field to use ground coordinates after a site calibration. Alternatively, set the *Coordinates* field to *Grid*.

3. Select the *Use geoid model* check box, and select a geoid model to calculate a Geoid/Inclined plane vertical adjustment after a site calibration.

Any points measured using GPS are displayed only as WGS-84 coordinates. Any points measured using a conventional instrument are displayed with null (?) coordinates.

Opening a Job

To open a job, highlight the name of the required job and tap .

Copying a Job

To copy a job, highlight the name of the job to be copied and tap .

Enter a name for the new job in the *To name* field and tap . The complete job is copied.



Tip – Use Windows Explorer to rename a file.

Copying between Jobs

Use this option to copy data between jobs. You can copy the following data:

- Calibration
- All control points
- Calibration and control points
- Roads
- Points

To copy data from another job:

1. From the main menu, select *Files / Copy between jobs*.
2. In the *Job to copy from* field, select the name of the job that contains the data you want to copy.
3. In the *Job to copy to* field, select the name of the job that you want to copy the data into.
4. In the *Copy* field, select the appropriate option for the data that you want to copy.
5. If you want to copy a point, select the *Copy duplicate points* check box, even if the point already exists in the job that you are copying to.

If you select the *Copy duplicate points* check box, the *Overwrite* check box appears. Select this if you want the duplicate points you copy to overwrite (delete) the points in the job you are copying to. Tap .

When copying points, if the two jobs have different calibrations, the following message appears:

Calibrations differ. Copy calibration?

6. Tap or as appropriate. If you tap the calibration is also copied.

If duplicate points were copied, a warning message appears to show how many duplicates were copied.

Reviewing the Job Database

To review the database for the current job, see *Reviewing the Database*, page 15.

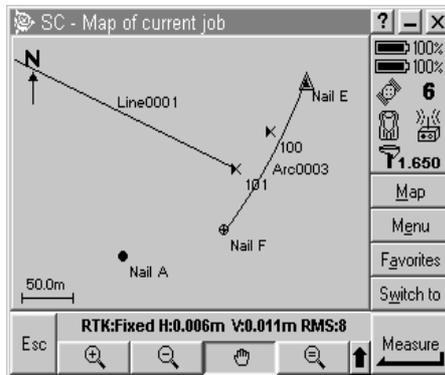
Map of Current Job

The *Map of current job* screen is a graphical representation of the features (points, lines, arcs) in the job database. You can move around the map, hide or display different parts of the map, and select features for common tasks. You can also display a background map.

To access the *Map of current job* screen, do one of the following:

- Tap Map.
- From the main menu, select *Files / Map of current job*.

A screen, similar to the following one, appears:



Different symbols identify different point types. The current position of the GPS antenna is shown as a vertical/horizontal cross (+).

The current orientation of a conventional instrument is shown by a dotted line extending from the instrument to the end of the screen, or to the prism when a distance is measured. The location of the prism is shown as a cross (+).

If there is a point with the same name as another point in the database, the point with the higher search class is displayed. For more information about how the Trimble Survey Controller software uses search classes, see Appendix B, Database Search Rules.

Note – Only grid coordinates are displayed. If you have not defined a projection, only points stored as grid coordinates appear.

Note – If the Grid coords field in the Cogo settings screen is set to Increase South–West or Increase South–East, this screen is rotated by 180°. The letter N on the north arrow denotes Grid 0°.

Table 3.1 describes the map softkeys that you can use to navigate around the map or to change the map display options. The effect on tapping on the map depends on the *active* softkey selected. When no softkey is selected, the map is in Select mode. For more information on selecting features from the map, see Selecting Features, page 51.

Table 3.1 Softkeys in map of current job screen

Softkey	Function
	Tap the softkey to zoom in to the center of the map area. Tap and hold on the softkey to make it <i>active</i> . Tap on an area of the map to zoom in to, or drag a box around the area you want to view. Tap the softkey again to deselect it.
	Tap the softkey to zoom out from the center of the map area. Tap and hold on the softkey to make it <i>active</i> . Tap on area of the map to zoom out from. Tap the softkey again to deselect it.
	Shifts the center of the map area to another part of the map. Tap on a part of the map to center the area, or tap and drag the map area to where you want to pan.
	Zooms to extents—shows all features on the screen.
	Displays the other softkeys (see below).
	Shows a legend for the feature symbols and lets you choose which features to display. Place a check mark against the features you want displayed.

Table 3.1 Softkeys in map of current job screen (Continued)

Softkey	Function
	Displays the <i>Pan to point</i> screen. Enter a point name and scale value.
	Selects a background map. For more information, see Background Map, page 54.
	<p>Changes the labels that are displayed next to the points. (The names of continuous points are not displayed.) Choose from By name, By code, or None. You can also choose whether to display the point symbols and coded features for each point. If the <i>Display coded features</i> check box is selected, the Trimble Survey Controller software draws lines between points if their feature codes have certain display properties. When you create or edit a feature code, use the  softkey to specify the feature code's display properties.</p> <p>To display the points in the stakeout list, select the <i>Display stakeout list points</i> check box. The points are displayed with a hollow flag icon next to them ().</p> <p>Warning: If you select the <i>Display stakeout list points</i> check box, the map display takes longer to update.</p>

Table 3.2 shows the symbols that appear when you tap the  softkey.

Table 3.2 Feature symbols

Symbol	Filter element	Symbol	Filter element
	Topo points (GPS)		As-staked points
	Face 1 Topo points (Conventional)		Face 2 Topo points (Conventional)
	Keyed in points (normal)		Keyed in points (control)
	Face 1 / Face 2 Matched pair		Calibration points
	Mean turned angle		Cogo points (computed)
	Observed control points		Rapid points

Table 3.2 Feature symbols (Continued)

Symbol	Filter element	Symbol	Filter element
	FastStatic points		Laser points
	Base points		Resection points
	Check points		Continuous points
	Offset points		Copied control points
	Intersection points		Copied normal points
	Copied as staked points		Traverse points
	Lines		Roads
	Arcs		Comma-delimited file points

Selecting Features

You can use the *Map of current job* screen to select features (points, lines, curves) for various tasks.

To select a feature on the screen, tap the required feature.

The selected feature is highlighted and displayed in reverse video (white on black). If there is more than one feature within the highlighted area, a list of the features within this area appears. Select the features as required. Tap OK or tap somewhere away from the list to return to the map.

To select multiple features, do one of the following:

- Drag a box around the points that you want to select.
- Tap each feature that you want to select.

To deselect a feature from the map, do one of the following:

- Tap the selected feature to deselect it. If there is more than one feature within the highlighted area, a list of features within this area appears. Deselect the features as required.
- Tap and hold on the map and select *List selection* from the shortcut menu. A list of the selected features appears. Deselect the features as required.
- To clear the entire selection, double-tap somewhere away from the selected features. Alternatively, tap and hold on the map and select *Clear selection* from the shortcut menu.

Using the Map for Common Tasks

The following sections describe the ways you can use the map to perform functions on the selected features.

Measuring from the map

When you have no features selected, tap **Measure** to measure your current position.

Staking out from the map

When you select features from the map, the **Stakeout** button becomes available. Tap it to stake out the selected features.

If more than one point is selected, the points are added to the *Stake out points* list where they can be selected for stakeout.

If the selection contains different feature types (points, lines, arcs), only features of the first type selected can be staked out from the map. To stake out the other feature types, clear the selection then reselect the other features.

Alternatively, double-tap a feature to stake out. If there is more than one feature within the highlighted area, a list of features within this area appears. Select the feature that you want to stake out.

You can also use the map shortcut menus to stake out features. For more information, see the following section.

Accessing tasks from the shortcut menu

The *Map of current job* screen shortcut menus provide quick access to common tasks. The available tasks depend on the number and type of features selected.

To access the shortcut menu, tap and hold on the screen. Alternatively, tap and hold on the feature when making a selection. Table 3.3 shows the options available from the shortcut menu. The ✓ symbol against a task shows that you can access it through the shortcut menu for the feature at the top of that column.

Table 3.3 Shortcut menu options

Task	Feature					
	No features	One point	Two points	Three or more points	Line	Arc
Review	–	✓	✓	✓	✓	✓
List selection	–	✓	✓	✓	✓	✓
Clear selection	–	✓	✓	✓	✓	✓
Delete	–	✓	✓	✓	✓	✓
Stakeout	–	✓	✓	✓	✓	✓
Navigate to point	–	✓	–	–	–	–
Turn to point	–	✓	–	–	–	–
Compute inverse	–	–	✓	✓	–	–
Compute area	–	–	–	✓	–	–
Subdivide a line	–	–	–	–	✓	–
Subdivide an arc	–	–	–	–	–	✓
Key in point	✓	–	–	–	–	–
Key in line	–	–	✓	–	–	–

***Note** – If you select a point with the same name as another point in the database, then select the Review or Delete option from the shortcut menu, a list of the duplicate points appears. Select the point you want to review or delete.*

Using field fill-in

Field fill-in allows you to enter feature names into fields by selecting from the map.

To enter a feature using field fill-in:

1. From the *Map of current job* screen, select the required feature(s).
2. Access the screen into which you are entering features.

The selected feature(s) are automatically entered into the appropriate fields. When more than one feature is selected, the fields are filled in the order that the features were selected.

To enter another feature into the field, using the map, tap **Map** then select the required feature. Tap **Esc** to return to the previous screen.

Using the Map Selection list

If you selected features from the *Map of current job* screen, the *map selection* button  becomes available on the right side of the feature name field. Tap it to access a list of the selected features. Only feature types (points, lines, arcs) that are specific to the field are shown.

Background Map

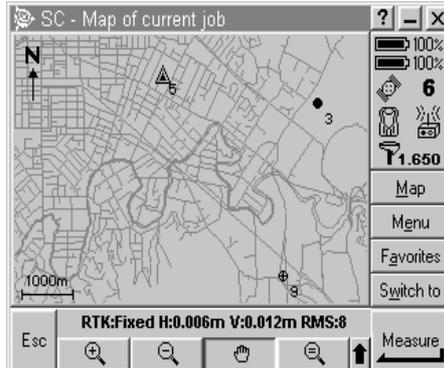
Use the **Bkgrnd** softkey to select a map to be displayed in the background layer of the *Map of current job* screen. You can display more than one background map at one time. The features are visible but cannot be selected, edited, or deleted.

Use the Trimble Data Transfer utility to transfer background map files to the Trimble Survey Controller software.

The Trimble Survey Controller software supports AutoCAD (ASCII) files (*.dxf). The following entities are supported:

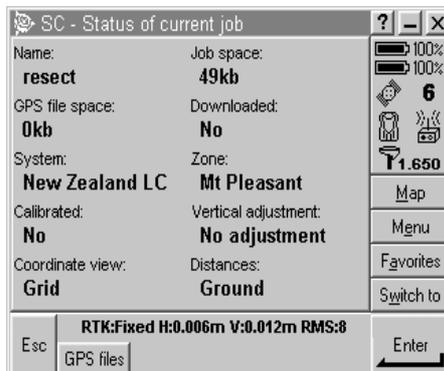
- 3D FACE, ARC, CIRCLE, INSERT, LINE, LWPOLYLINE, POINT, POLYLINE, TEXT

The following screen shows a typical map of a current job:



Status of Current Job

From the main menu select *Files / Status of current job*. The following screen appears:



Selecting Comma Delimited (.csv) Files

Use a comma delimited (.csv, or Comma Separated Values) file to access points that do not exist in the current job, or that you do not want to import into the job.

You can use points in a .csv file for:

- staking out without having the design points in the job
- entering into *Point name* fields, such as for Cogo functions
- navigating to control or check shots from previous surveys

Transferring .csv Files

Before you transfer a .csv file, make sure the data in the file is in the format: *Point name*, *First ordinate* (Northing or Easting), *Second ordinate* (Northing or Easting), *Elevation*, *Point code*.

Note – *The coordinate order (Northing and Easting ordinates) in the .csv file must be the same as the setting in the Coordinate order field in the Units screen.*

To transfer a .csv file to the Trimble Survey Controller software:

1. Use the Data Transfer utility or Microsoft ActiveSync to transfer the file from the office computer to the \Trimble Data folder on the TSCe data collector. For more information, see Chapter 4, Data Transfer.
2. From the main menu, select *Files / Comma delimited files*. The *Comma delimited files* screen appears.
3. Tap the file(s) that you want to use for the current job or tap **All** to select all files. You can access points from more than one file.
4. Tap **Enter**.

The next section describes how to access the points in a .csv file.

Note – To import points from a .csv file to the current job, select *Files / Import/Export / Receive data*. For more information, see *Receiving ASCII Data from an External Device*, page 77.

Accessing Points in .csv Files

To access points in a .csv file, use one of the following methods:

- Select from the map
- Key in the point name
- Use the *Stake out points* list

When you access a .csv point for a task other than for stakeout, it is copied to the job database.

Note – If two points in one or more .csv files have the same name, only the first point is used. If there is a point with the same name in the database, the point in a .csv file is not used.

Selecting from the map

Points in a .csv file appear as comma (↗) symbols in the map.

You can select them for various tasks, such as staking out, as you would with points stored in the job database. For more information, see *Map of Current Job*, page 48.

Note – You can only review points in a .csv file from the map.

Keying in a point

To enter a point from a .csv file into a *Point name* field, access a *Point name* field and key in the point name.

Note – You cannot use the softkey to select points from a .csv file.

Adding points to the Stake Out Points list

Add a point to the *Stake out points* list using the *Select from files* option. For more information, see *Points*, page 311 and *Staking Out a Point*, page 385.

System Units

Set the units and the preferred format of the units at any time; the job database is immediately updated. A job retains the settings assigned to it, even if the units or format change in a subsequent job.

To change the units or format:

1. Select *Configuration / Job / Units*.
2. Highlight a field, for example *Angles*, and select a format from the list.
3. Change the other fields as required:
 - The setting for the *Coordinate view* field determines what is displayed when you review the database. See Table 3-4.

Table 3-4 Coordinate view options

Option	Description
WGS84	View as WGS-84 Latitude, Longitude, and Height
Local	View as local ellipsoidal Latitude, Longitude, and Height
Grid	View as Northing, Easting, and Elevation
ECEF (WGS84)	View as Earth-Centered-Earth-Fixed WGS-84 X, Y, Z coordinates
Az VA SD	View as azimuth, vertical angle, and slope distance
HA VA SD (raw)	View as horizontal angle, vertical angle, and slope distance

Table 3-4 Coordinate view options (Continued)

Option	Description
Az HD VD	View as azimuth, horizontal distance, and vertical distance
HA HD VD	View as horizontal angle, horizontal distance, and vertical distance
Δ Grid	View as differences in Northing, Easting, and Elevation from the instrument point

Note – If the coordinate value for a point is “?”, it is possible that the point is stored as a GPS point but the Coordinate view field is set to Local or Grid, and you have not defined a datum transformation and projection. Change the Coordinate view setting to WGS-84, define a datum transformation and/or projection, or calibrate the job.

Alternatively, it is possible that the point is stored as a polar vector from another point but that source point is deleted. Undelete it.

- The grade of a slope can be displayed in one of the following formats: angle, percent, or ratio.

The ratio can be displayed as *Rise:Run* or *Run:Rise*. Figure 3.1 illustrates these.

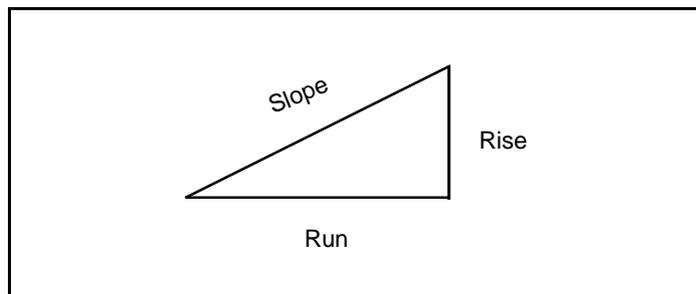


Figure 3.1 Rise and run in the grade display

The setting in the *Laser VA display* field determines whether the laser measurements are displayed as vertical angles measured from the zenith, or inclinations measured from horizontal.

Use the *HA VA angle display* field to specify how horizontal and vertical angles are displayed.

4. Tap  to accept the settings and return to the *Job* menu.

System Settings and Corrections

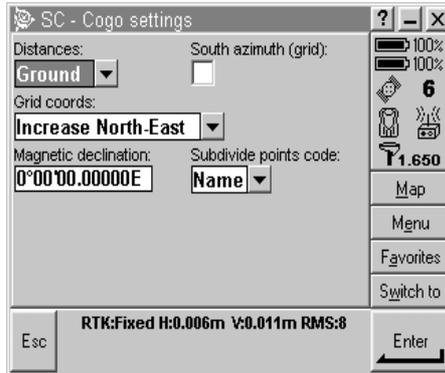
Various settings and corrections affect how data and results are displayed on the TSCe data collector. It is important to understand the effects of the settings used.

Note – If you change the settings in a subsequent job, the original job retains its settings.

When you change a setting, a note is recorded in the job database.

Cogo Settings Screen

To access the list of settings and corrections, select *Configuration* from the main menu. Then select *Job / Cogo settings*. The following screen appears:



Change these settings as required. They are applied to the current job (if one is open) or to the next job that you create.

Options Softkey

When you select *Cogo* from the main menu, an **Options** softkey appears in some of the screens. This softkey lets you change certain settings or corrections.

Note – Parameters that are set in the Options screen only apply to the current job. Different jobs can have different settings.

Distance Display

The *Distances* field defines how distances are displayed and which distances are used for calculations in the Trimble Survey Controller software. Select one of the following options:

- Ground (the default setting)
- Ellipsoid
- Grid

Figure 3.2 shows the options between points A and B.

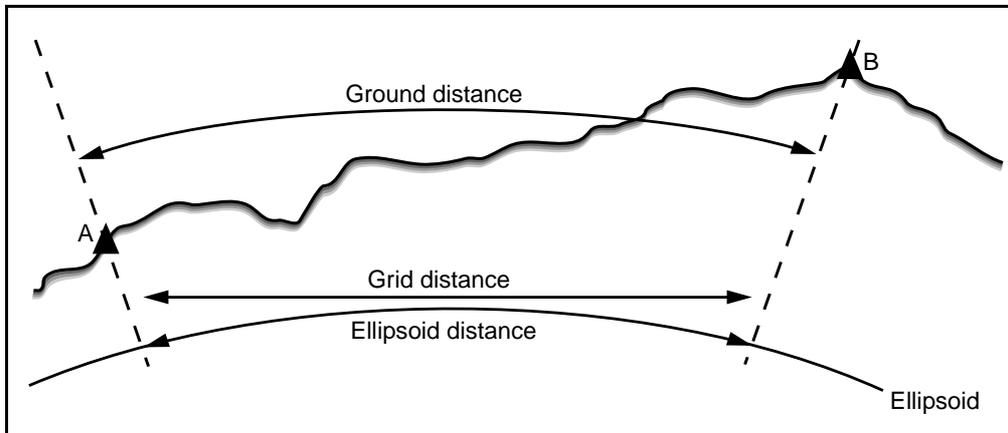


Figure 3.2 Distances used by the Trimble Survey Controller software between points A and B

Note – Distance and height/elevation fields have the suffix (*grnd*), (*ell*), or (*grid*), depending on the value in the *Distances* field.

Ground distance

A ground distance is the horizontal distance calculated between the two points at the mean elevation parallel to the chosen ellipsoid.

If an ellipsoid has been defined in the job and the *Distances* field is set to *Ground*, the distance is calculated parallel to that. If no ellipsoid has been defined, the WGS-84 ellipsoid is used.

Ellipsoid distance

If the *Distances* field is set to *Ellipsoid* then a correction is applied and all distances are calculated as if on the local ellipsoid, which usually approximates to sea level. If no ellipsoid has been specified, the WGS-84 ellipsoid is used.

Note – If the coordinate system for a job is defined as *Scale factor only*, ellipsoid distances cannot be displayed.

Grid distance

If the *Distances* field is set to *Grid*, the grid distance between two points is displayed. This is the simple trigonometrical distance between the two sets of two-dimensional coordinates. If the coordinate system for the job is defined as *Scale factor only*, and the *Distances* field is set to *Grid*, the Trimble Survey Controller software displays ground distances multiplied by the scale factor.

Note – A grid distance between two measured GPS points cannot be displayed unless you have specified a datum transformation and a projection, or performed a site calibration.

Curvature Correction

In the Trimble Survey Controller system, all ellipsoid and ground distances are parallel to the ellipsoid.

Azimuth Display

The azimuth displayed and used by the Trimble Survey Controller software depends on the coordinate system that you defined for the current job:

- If you defined both a datum transformation and a projection, or if you selected *Scale factor only*, the grid azimuth is displayed.
- If you defined no datum transformation and/or no projection, the best available azimuth is displayed. A grid azimuth is the first choice, then a local ellipsoidal azimuth, then the WGS-84 ellipsoid azimuth.
- If you are using a laser rangefinder, the magnetic azimuth is displayed.

In the *Survey / Offsets* screen you can select which azimuth is used. For more information, see *Azimuth plus angle*, page 165.

The azimuth that the Trimble Survey Controller software uses is identified by the suffix (grid), (local), (WGS84), or (mag).

South Azimuth

If a south azimuth display is required, set the *South azimuth* field to *Yes*. All azimuths still increase clockwise. Figure 3.3 shows the effect of setting the *South azimuth* fields to No or Yes.

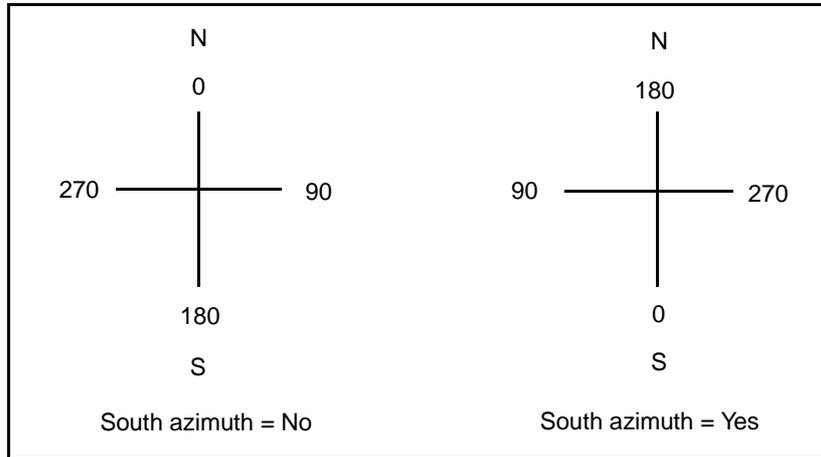


Figure 3.3 South azimuth setting

Grid Coordinates

Use the *Grid coords* field to set the grid coordinates to increase in one of the following sets of directions:

- north and east
- south and west
- north and west
- south and east

Figure 3.4 shows the effect of each setting.

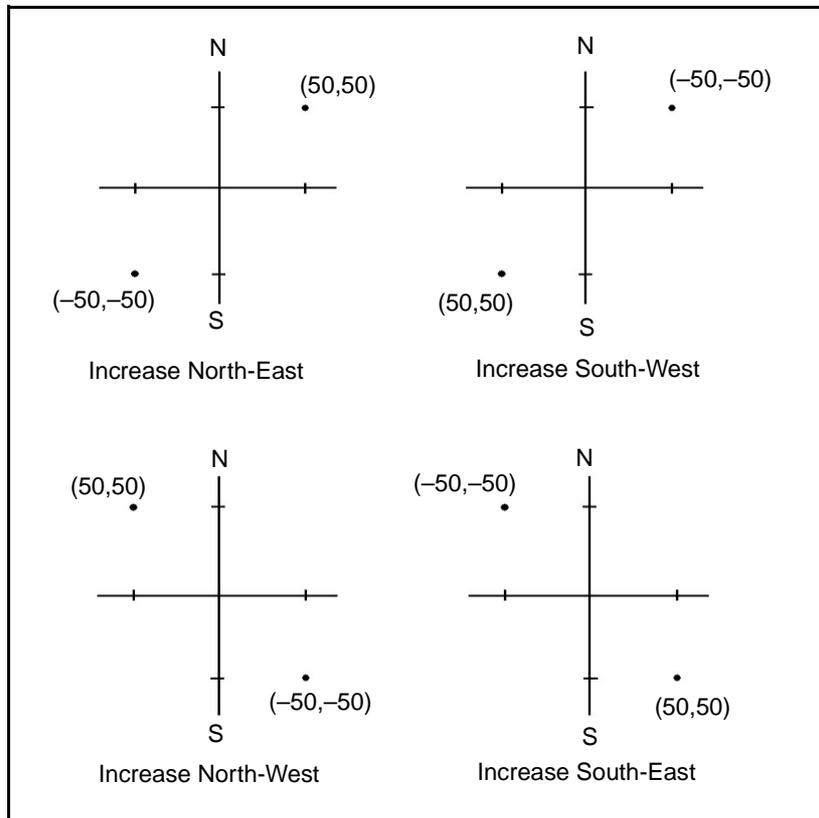


Figure 3.4 Grid coordinates setting

Magnetic Declination

Set the magnetic declination for the local area if magnetic bearings are being used in the Trimble Survey Controller software. You can use magnetic bearings if you choose the Brng-dist from a point method in the *Survey/Offsets* screen.

Enter a negative value if magnetic north is west of true north. Enter a positive value if magnetic north is east of true north. For example, if the compass needle points 7° to the east of grid north, the declination is +7° or 7°E.

Note – Use the published declination values if available.

Subdivide Pts Code

When you subdivide a line or arc, a number of points are created. Use the *Subdivide pts code* field to specify the code that the new points will be allocated. Choose from the name or the code of the line or arc that is to be subdivided.

Project Height

The project height can be defined as part of the coordinate system definition. To find it, select *Configuration / Job / Coordinate System* in either the *Library* or *Key in / Projection* dialogs.

If a point has no elevation, the Trimble Survey Controller software uses the project height for Cogo calculations. If you combine GPS and 2D conventional observations, set the *Project height* field to approximate the height of the site. This height is used with 2D points to calculate grid and ellipsoid distances from measured ground distances.

If you have defined a projection and you intend to do a 2D survey, you must enter a value for the project height. This reduces measured ground distances to ellipsoid distances.

If you edit the project height (or any other local site parameter) after calibrating, the calibration becomes invalid and must be reapplied.

Data Transfer

In this chapter:

- Introduction
- Data transfer between the TSCe data collector and the office computer
- Data transfer between the Trimble Survey Controller software and another device

Introduction

This chapter describes how to transfer data between the TSCe data collector and an office computer. It lists the types of files that can be transferred, and shows how to connect the equipment for transfer. It then shows how to transfer point names, point codes, and grid coordinates in ASCII format between the TSCe data collector and a variety of conventional instruments, data collectors, and office computers.

Data Transfer between the TSCe Data Collector and the Office Computer

You can transfer various types of files between the TSCe data collector and the office computer, including data collector (.dc) files, feature code files, digital terrain models (DTM), and language files. The data transfer process on the data collector is controlled by the office computer software when you connect the data collector to the office computer and select the appropriate options.

You can transfer files using:

- The Trimble Data Transfer utility
- The Trimble Data Transfer utility with Microsoft ActiveSync software enabled
- Microsoft Explorer with the Microsoft ActiveSync software enabled

You can also transfer data to and from the TSCe data collector using other Trimble software packages. For more information, refer to the help provided with the Trimble office software.

***Note** – To transfer ASCII data between the TSCe data collector and other devices, see *Data Transfer between the Trimble Survey Controller Software and Another Device*, page 72.*

Using the Trimble Data Transfer Utility

Use the Trimble Data Transfer utility to transfer files between the Trimble Survey Controller software and the office computer.

For more information on using Trimble's Data Transfer utility, see the Trimble Data Transfer Help and the Trimble Survey Controller Release Notes.

Using the Trimble Data Transfer Utility with the Microsoft ActiveSync Software Enabled

To transfer files between the Trimble Survey Controller software and the office computer:

1. Make sure that the TSCe data collector and office computer are switched on.

Disconnect any devices that are communicating with the data collector, and close down any applications to ensure that the communications ports are available.

2. Connect the TSCe data collector to the office computer. Use one of the following methods:
 - Serial cable
 - USB cable
 - Infrared
 - Network (Ethernet) card.
3. The Microsoft ActiveSync icon on your Windows taskbar will start spinning and the TSCe data collector will prompt you with the message, Connect to desktop. Tap .

4. If the message does not appear on the TSCe data collector and the Microsoft ActiveSync icon does not spin, there is a connection problem. Check that the connection settings in the Microsoft ActiveSync software are correct and that there are no applications using the COM port on the TSCe data collector. If necessary, perform a soft reset (warm boot). For more information, see *Rebooting*, page 416.

Note – Always connect the TSCe data collector to the Microsoft ActiveSync software with the Guest connection. Partnership connections between the data collector and your office computer are not supported. For more information about Guest connections, see the Microsoft ActiveSync Help.

5. On the office computer, start the Data Transfer utility. The rest of the procedure is controlled by this software.

Note – To transfer files to and from earlier versions of the Trimble Survey Controller software or Trimble GPS receivers, turn off the Microsoft ActiveSync software and use the Trimble Data Transfer utility directly.

Using Microsoft Explorer with the Microsoft ActiveSync Software Enabled

You can use Microsoft's Explorer and ActiveSync software to move or copy files to or from the TSCe data collector. Use the software to transfer files that do not require conversion by the Data Transfer utility (for example, comma delimited (.csv) files). See Table 4.1.

From the Microsoft ActiveSync window:

1. Click **Explore** to move or copy files between the office computer and the TSCe data collector for sharing information. Alternatively, use Windows Explorer to move or copy files.
2. Click **Tools** to backup and restore files.

For more information on using Microsoft ActiveSync software to transfer files, refer to the Microsoft ActiveSync Help.

File Conversion

When data is transferred to and from the Trimble Survey Controller software, some files are converted for use in the Trimble software.

Table 4.1 lists the files that are used in the Trimble Survey Controller software and the file types they are converted to when transferred to and from Trimble office software.

Table 4.1 Trimble Survey Controller files

PC	TSCe	Description	Trimble Data Transfer	Microsoft Explorer using ActiveSync
.dc	.job	Survey Controller job files	Y	N
.csv	.csv	Comma Delimited (CSV) files	Y	Y
.dtx	.dtm	Digital Terrain Model files	Y	N
.ttm	.ttm	Triangulated Terrain Model files	Y	Y
.fcl	.fal	Feature and Attribute Library files	Y	N
.ddf	.fal	Data Dictionary files	Y	N
.ggf	.ggf	Geoid Grid files	Y	Y
.cdg	.cdg	Combined Datum Grid files	Y	Y
.pgf	.pgf	UK National Grid files	Y	Y
.dxf	.dxf	Background Map files	Y	Y
.ini	.dat	Antenna files	Y	N
.lng	.lng	Language files	Y	Y
.wav	.wav	Sound files	Y	Y
.dat	.dat	GPS data files	Y	Y

When a .dc file is transferred to the Trimble Geomatics Office software, any GPS data files associated with that file are also transferred. Information about the .dc file format is available from the Trimble website (www.trimble.com). For more information, contact your local Trimble dealer.

Note – If a Trimble Geomatics Office project uses a geoid model, remember to also transfer the geoid file (or the subgridded part of it) when transferring the job into the Trimble Survey Controller software.

AutoCAD Land Development Desktop software

Use the Trimble Link™ software to transfer data between the Trimble Survey Controller software and Autodesk's AutoCAD Land Development Desktop software.

When job data is transferred from the Trimble Survey Controller software to the AutoCAD Land Development Desktop software, a .tic file is created.

Data Transfer between the Trimble Survey Controller Software and Another Device

This section shows you how to use the ASCII data transfer function in the Trimble Survey Controller software. Use this function to transfer point names, point codes, and grid coordinates in ASCII format between the TSCe data collector and a variety of conventional instruments, data collectors, and office computers.

In addition, you can transfer ASCII files directly to the office computer using third-party download software, such as HyperTerminal.

Note – Only points with grid coordinates are transferred when you use the ASCII data transfer function. If the job does not have a projection and datum transformation specified, GPS points cannot be transferred. Furthermore, deleted points, and any points stored as polar vectors from a deleted point, cannot be transferred.

Transferring ASCII Data to and from an External Device

You can transfer ASCII data to and from an external device or office computer in the following formats:

- Geodimeter[®] (Area)
- Comma delimited (*.csv)
- SDR33 coordinates
- SDR33 DC
- SC Exchange
- TDS
- Topcon (GTS-7)
- Topcon (FC-5)
- Trimble DC v10.0
- Zeiss (R5)
- Zeiss (Rec E/M5)
- Zeiss (Rec500)

In an SC Exchange .dc file, all observations are reduced to WGS-84 positions and grid positions (coordinates). Use this file format to transfer .dc files between different versions of the Trimble Survey Controller software running on the TSCe and TSC1 data collectors.

The next sections describe how to connect the TSCe data collector, and how to send and receive data to and from the Trimble Survey Controller software.

Sending ASCII Data to an external device

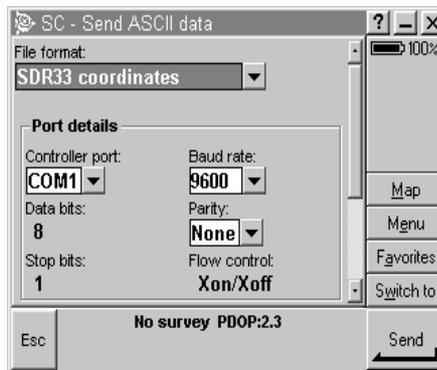


Warning – When sending data to a device that does not include a units setting as part of its file, make sure that the Trimble Survey Controller file uses the units setting of that device.

If you are not sure whether the device file includes a units setting, set the Trimble Survey Controller file to the same units as the device.

To send ASCII data to an external device:

1. Select the files to transfer:
 - a. Select *Files / Import/Export / Send ASCII data*. The following screen appears:



- b. Use the *File format* field to specify the type of file that you want to send.

If the *File format* field is set to Comma Delimited (*.CSV), SC Exchange or SDR33 DC, the *Send to* field appears. Set the field to *External device*.

2. Set the transfer parameters:
 - a. Set the *Controller port* field to the TSCe data collector port you are using for the transfer.
 - b. Set the *Baud rate* and *Parity* fields to match the corresponding parameters on the device that you are communicating with.

Note – If the *File format* field is set to *Comma Delimited (*.CSV)*, set the *baud rate* correctly on the external device. If appropriate, also set the *flow control (xon/xoff)*.

- c. If you are transferring a .dc file, and you want the Trimble Survey Controller software to include a checksum when the file is transferred, select *On* in the *Checksum* field.

Note – For the *Geodimeter (Area)*, *SDR33*, *TDS*, *Topcon (GTS-7)*, *Topcon (FC-5)*, *Zeiss (R5)*, *Zeiss (Rec E/M5)*, and *Zeiss (Rec500)* output options, the format is controlled by the external device.

3. Set the file parameters:
 - a. If the *File format* field is set to *SDR33 coordinates* or *TDS*, the *Job name* field appears. Enter a name for the file that is created when the data is transferred.
 - b. Set the *Point name* field to *Unchanged* or *Auto-generate*. *Unchanged* sends the point names as they appear on the TSCe data collector. *Auto-generate* adds two extra fields:
 - Use the *Start point name* field to specify the name of the first point to be transferred.
 - Use the *Auto point step size* field to define the amount by which the *Start point* value is incremented or decremented when the Trimble Survey Controller software generates point names for subsequently transferred points.

Note – If the *File format* field is set to *TDS* and the *Point name* field is set to *Unchanged*, a point will only be transferred if the point name is less than eight characters long and contains numeric characters only.

- c. Use the *Point code* field to specify what is sent to the external device selected in the *Code* field:
 - Select *Use point code* to send the point code.
 - Select *Use point name* to send the point name.

Note – If you have used long codes (up to 42 characters) in the *Trimble Survey Controller* software, and the file format you are transferring to does not support long codes, the codes will be shortened.

- d. If the *File format* field is set to *SDR33 coordinates*, there is an *Output notes* check box. Select this to output all user-entered notes with the point data. The notes are output in SDR33 record 13NM format.
- e. If the *File format* field is set to *Comma Delimited (*.CSV)*, you can specify the format of the data to be output. Five fields appear: *Point name*, *Point code*, *Northing*, *Easting*, and *Elevation*. Using the options provided, select a position for each field. Select *Unused* if you do not want to send a particular value. For example:

<i>Point name</i>	Field 1
<i>Point code</i>	Unused
<i>Northing</i>	Field 3
<i>Easting</i>	Field 2
<i>Elevation</i>	Field 4

- 4. Transfer the files:
 - a. When the format details are complete, tap .
 - b. If you are sending points (not a .dc file), the *Select points* screen appears. Select the points to send.

The procedure is similar to that used to create a *Stake out points* list. For more information, see *Points*, page 311.

- c. The Trimble Survey Controller software prompts you to initiate receiving on the instrument that you are sending data to. For more information about receiving data, refer to the manual for the receiving device.

When the other device is ready to receive, tap Yes to send the data. The data is transferred.

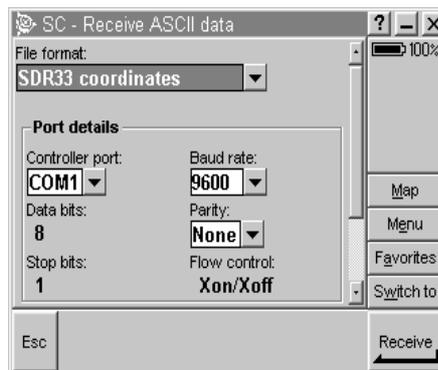
Receiving ASCII Data from an External Device



Warning – When receiving data from a device that does not include a units setting as part of its file, make sure that the Trimble Survey Controller file uses the units setting of that device. If you are not sure whether the device file includes a units setting, set the Trimble Survey Controller file to the same units as the device.

To receive ASCII data from an external device:

1. Select the files to send:
 - a. Select *Files / Import/Export / Receive ASCII data*. The following screen appears:



- b. In the *File format* field, specify the device that you want to receive data from.

If the *File format* field is set to *Comma Delimited (*.CSV)*, *SC Exchange*, or *SDR33 DC*, the *Receive from* field appears. Set this field to *External device*.

2. Set the transfer parameters:

- a. In the *Port details/Controller port* field, select the TSCe data collector port used for the transfer.

- b. Set the *Baud rate* and *Parity* fields to match the corresponding parameters on the device that the Trimble Survey Controller software is communicating with.

Note – If the *File format* field is set to *Comma Delimited (*.CSV)*, set the *baud rate* correctly on the external device. If appropriate, also set the *flow control (xon/xoff)*.

- c. If you are transferring a .dc file, and you want the Trimble Survey Controller software to validate the checksum when the file is transferred, select *On* in the *Checksum* field.

3. The option in the *File format* field determines what you do next:

- If one of the following options is selected, the format is controlled by the external device:

Geodimeter (Area) SDR33

TDS

Topcon (GTS-7)

Topcon (FC-5)

Zeiss (R5)

Zeiss (Rec E/M5)

Zeiss (Rec500)

Use the *Point name* field to define how the point names in the data are received.

Note – Trimble Survey Controller point names have a maximum of 16 characters, but some points received from other devices can exceed this. If point names have 16 characters or more, choose either *Truncate left* or *Truncate right*.

- If the Comma Delimited (*.CSV) option is selected, you can specify the format of the data that is received. Five fields appear: *Point name*, *Point code*, *Northing*, *Easting*, and *Elevation*.

Using the options provided, select a position for each field. Select *Unused* if a particular value is not present in the file being received. For example:

<i>Point name</i>	Field 1
<i>Point code</i>	Unused
<i>Northing</i>	Field 2
<i>Easting</i>	Field 3
<i>Elevation</i>	Field 4

4. Store the files:
 - a. When the format details are complete, tap .
 - b. The Trimble Survey Controller software prompts you to initiate sending on the external device. For more information about sending data, refer to the manual for the sending device.

When sending is initiated, the Trimble Survey Controller software starts to receive data, and a progress bar appears.

When the transfer is complete, the Trimble Survey Controller software automatically terminates the operation and saves the received data.

- c. If it is clear that the transfer is complete but the operation has not been terminated, tap **Esc**. The following message appears:

Transmission interrupted. What would you like to do now?

Do one of the following:

- Tap **Continue** to return the Trimble Survey Controller software to receive mode.
- Tap **Finish** to terminate the operation and save any received data to the current job.
- Tap **Cancel** to terminate the operation and discard any received data.

Using Feature and Attribute Libraries

In this chapter:

- Introduction
- Transferring a feature and attribute library
- Creating a feature and attribute library
- Adding, deleting, and editing feature codes
- Adding, deleting, and undeleting a feature and attribute library
- Collecting feature and attribute information

Introduction

Feature coding is a method of describing each point using an alphanumeric code. These codes are later processed by the office software to generate plans.

Some feature codes also have attributes. An attribute is an extra piece of descriptive information about a point.

Note – You can use attribute information in the Trimble Geomatics Office software. You do not need to process the feature codes.

Attributes and feature codes are combined in a feature and attribute library that can be transferred to the TSCe data collector. During a survey, you can extract feature codes from this library quickly and easily. Feature codes that have associated attributes prompt you to enter the necessary attribute information, so that the appropriate data is always collected.

To use an existing feature and attribute library, transfer it to the TSCe data collector. You can then use the Trimble Survey Controller software to add, modify, or delete feature codes from that library or you can create a new library.

As you work, assign a feature code to each point and enter any corresponding attribute data. Later, use the office software to:

- transfer the points
- process the feature codes and attribute data
- automatically generate a plan
- export the attributes in a range of GIS export formats

Transferring a Feature and Attribute Library

To transfer a feature and attribute library file from the office computer to the TSCe data collector, use a package such as the Trimble Geomatics Office software or Data Transfer utility.

The file transfer is controlled by the office software. For more information, see *Data Transfer between the TSCe Data Collector and the Office Computer*, page 68.

Creating a Feature and Attribute Library

Create a feature and attribute library, using the Trimble Geomatics Office Feature and Attribute Editor, or GPS Pathfinder® Office Data Dictionary Editor. Alternatively, use the Trimble Survey Controller software. Libraries created using software such as these can contain feature codes with attributes that automatically prompt you for attribute entry. Features codes created using the Trimble Survey Controller software, however, do not have attributes associated with them.

To create a feature and attribute library in the Trimble Survey Controller software:

1. Select *Configuration / Feature & attribute libraries*. Tap .
2. Type the name of the new feature and attribute library and tap . Tap again to accept the screen.

Note – *To copy or delete a feature an attribute library, use Windows Explorer. For more information, see File Management, page 19.*

Adding, Deleting, and Editing Feature Codes

If a feature and attribute library is transferred to the Trimble Survey Controller software, some of the feature codes can contain attribute subrecords. Feature codes with attributes have an attribute icon () next to the code in the library.

Note – If the library being used contains attributes, but no attributes have been stored, the checkmark icon () replaces the attribute icon ().

Once a feature code has attributes, that feature code cannot be added, deleted, or edited using the Trimble Survey Controller software. To change it, use the office software.

To add a feature code to a feature and attribute library:

1. From the main menu, select *Configuration / Feature & attribute libraries*.
2. Highlight the library name and tap . If the library has no features, the following message appears:
No features exist
3. Tap  and enter the new feature code. Tap .

The Trimble Survey Controller software limits the name of each feature code to 20 characters.

4. To set the display properties for the feature code, tap . If the *Display coded features* options is selected in the map options, the Trimble Survey Controller software draws lines between points based on the specified display properties.
5. Tap  to accept the new feature code.
6. To add another feature code to the library, tap .

To delete a feature code from a feature and attribute library:

1. From the main menu, select *Configuration / Feature & attribute libraries*.
2. Highlight the library name and tap .

3. Highlight the feature code to be removed and tap .
4. Repeat Step 3 for each feature code to be deleted.

To edit a feature code in a feature and attribute library:

1. From the main menu, select *Configuration / Feature & attribute libraries*.
2. Highlight the library name and tap .
3. Tap and edit the feature code.

The Trimble Survey Controller software limits each feature code to 20 characters.

4. Tap to accept the edits to the feature code.
5. Repeat steps 3 and 4 for each feature code to be edited.

Collecting Feature and Attribute Information

You can enter one or more feature codes in any *Code* field in the Trimble Survey Controller software. The maximum number of characters in these fields is 42. To enter a code, key it in or select it from a predefined library.

To select a feature code from a feature and attribute library:

1. Make sure the appropriate library is selected. (To do this, access the *Code* field and tap . Highlight the required library name and tap . The current library has a check mark next to it.)
2. To select a feature code from the library, do one of the following:
 - Type the first letter(s) of the feature code required. This highlights a feature code in the library that starts with the letters you typed. Tap to insert it in the *Code* field.
 - Press . When the library of codes appears, tap the required code to insert it in the *Code* field.

3. To select another feature code, repeat step 2.
4. When all codes are entered, tap  again.

Note – You cannot select a different feature and attribute library for the current job once a point with attributes is stored.

Names and Symbols

Feature code names that contain spaces appear in the Trimble Survey Controller software with a small dot between the words, for example, Fire•Hydrant. These dots do not appear in the office software.

Some symbols are not supported in feature and attribute libraries, for example ! and []. If you use unsupported symbols when creating a library in the office software, the Trimble Survey Controller software converts them to the underscore symbol “_” when they are transferred.

Using Feature Codes with Predefined Attributes

You can use feature and attribute libraries that were created using the Trimble Geomatics Office or Trimble Survey Office software, the Feature and Attribute Editor or Data Dictionary Editor utilities, to store additional attribute information for feature codes. In the Trimble Survey Controller software, these feature codes have an attribute icon () next to the feature code in the library.

When entering attribute information, key in values or select them from a list, depending on the library you created in the office software.

Note – Feature classifications defined in feature and attribute libraries as Point, Line, or Area in the office software all appear as Point features in the Trimble Survey Controller software.

You can enter attribute data before measuring a point or while measuring it. The  softkey appears when feature codes with attributes are used.



Tip – To capture attribute data more efficiently, use the office software to predefine default values, minimum and maximum ranges, auto-generated times and dates, and well-structured menu options. If you use auto-generated times, make sure that the time is set correctly on your TSCe data collector. For information on setting the TSCe time and data, see *Setting the Clock*, page 415.

Note – *If you specify in the office software that field entry is not permitted for an attribute, you cannot use the Trimble Survey Controller software to enter that attribute data.*

To enter attributes before measuring a point:

1. Enter the feature code and tap **Attrib**. A screen with the feature code and attribute fields appears.
2. Enter values in the attribute fields.

The maximum number of characters in text attribute fields is usually 100. Your definition of a feature and attribute library can specify fewer.



Tip – Use the **Repeat** softkey to repeat the last stored set of attributes for the current feature.

The **Prev** and **Next** softkeys appear when there are multiple feature codes with attributes in the *Code* field. Use them to swap between attributes.

To enter attributes while measuring a point:

1. Enter the feature code. The **Attrib** softkey appears.
2. Tap **Measure** to start measuring the point.
A screen with the feature code and attribute fields is displayed.
3. Enter values in the attribute fields. Tap **Store** to accept the attributes.
4. Tap **Store** to store the point and the associated attributes.

Attributes are stored after the point is stored.



Tip – The Trimble Survey Controller software can automatically store the point while you are still entering attribute data. To enable this, select the *Auto store point* check box in the survey style.

Resurveying Points that Already Have Attributes

To stake out and re-measure points for which you already have attribute data:

1. If the job is not yet in the Trimble Survey Controller software, transfer it from the Trimble Geomatics Office software.

Note – Transfer relevant features and attributes as well as the points.

2. From the *Survey Style / Survey* menu, choose *Stakeout*.
3. Set the as-staked point details:
 - Set the *As-staked name* field to *Design name*
 - Set the *As-staked code* field to *Design code*
4. Stake out the points.
5. Measure the as-staked point.

The attribute data displayed for the point is the attribute data that you entered previously. The defaults in the feature and attribute library are not used. Update the values as required.

Entering Attributes for a Point Using Feature Codes Without Predefined Attributes

Another way to enter attributes is through note, records using the  key.

You can enter several attributes for one point. For a point that has a feature code of Tree, for example, you can enter its type, height, girth, and spread as attributes.

To enter attributes for a point using the  key:

1. Measure, key in, or compute the point.
2. Tap  and select *Key in note*.
3. Enter the first attribute and press . Enter the data and press  again.

If a feature code and attribute library is selected for the job, it appears when you type the first letter of a code that is in the library.

4. Enter the next attribute and press . The attributes for a tree, for example, could be:

Type:Oak:Girth:1.0:Height:15:Spread:12

5. Repeat step 4 until all attributes are entered, then tap .



Tip – Use  to return to the screen where you stored the point without closing this window.

Note – Attributes collected using note records with “:” separators are processed as note records in the Trimble Geomatics Office software. For more flexibility in the office software, collect attributes using attribute subrecords or features from the feature and attribute libraries created in the office software.

Control Commands

With feature codes, points that have the same code can be joined by lines or represented by symbols on a plan. In a topographical survey, for example, survey the center line of a road and give it the code CL. Then set up the office software that processes the feature codes so that all points with the code CL are joined together.

However, if you survey the centerline of two different roads, and the points all use the code CL, the two centerlines will be joined together. To prevent this, use the code CL START for the first point on the first center line. Observe a succession of points with the code CL, then use the code CL END for the final point on the first center line.

Set up the feature code library for the office software to recognize these start and end codes as control commands.

Roding

In this chapter:

- Introduction
- Transferring or keying in road information
- Reviewing the road information
- Staking out points on the road by station and offset
- Measuring positions on the road

Introduction

This chapter shows you how to stake out roads and determine your position relative to a road design. It explains how to review roding information and select a point to stake out on a road. It shows how to navigate to a non-side-slope point and a side-slope point, and measure an as-staked point.



Warning – Do not stake out points and then change the coordinate system or perform a calibration. If you do, these points will be inconsistent with the new coordinate system and any points computed or staked out after the change.

Transferring or Keying in Road Information

Before staking out a road or determining your position relative to a road, key in or transfer a road definition.

For information on how to do this, see *Roads*, page 134, and *Templates*, page 144.

To transfer a road definition, use Trimble's RoadLink™ software, which is a module of the Trimble Geomatics Office software. For more information about how to transfer files see, Chapter 4, *Data Transfer*.

Each road is transferred as a job. To open a job, select *Files / Job management*.

Note – *Once the files are transferred, you can copy several roads into a single job. For more information, see Copying between Jobs, page 46.*

Each road transferred using the RoadLink software contains the coordinate system for the road. Roads always have grid coordinates.

Note – *The Trimble Survey Controller software treats all road distances, including stationing and offset values, as grid distances. The value in the Distances field (accessed by selecting Configuration / Job / Cogo settings) has no effect on the road definition or the way road distances are displayed. If a ground coordinate system is defined in either the Trimble Geomatics or Survey Controller software, then the grid coordinates are, in effect, also ground coordinates.*

Reviewing the Road Information

To review road information in the Trimble Survey Controller software:

1. Open the job.
2. From the main menu, select *Files / Review current job*.

The following section describes the roading records that appear.

Roading Records

Information about a road appears in the following order:

1. The name of the road. This record includes:
 - Horizontal alignment elements – These records appear in order of increasing stationing. There is a record for each alignment element.
 - Vertical alignment elements – These records appear in order of increasing stationing. There is a record for each alignment element.
 - Template records – Templates define the cross-sections used along the road. Template records show what templates are used at the various stations along the road. There is a record each time the template changes. These records appear in order of increasing stationing.

- Superelevation and/or widening records – There is a record each time the superelevation and/or widening changes. These records appear in order of increasing stationing.

2. The name of the template(s).

This record includes the template elements that define the cross-section of the road, starting from the centerline. Each record defines an element in the template.

Note – If a road has a horizontal and vertical alignment but no templates, all offset points display a null (?) value in the V.Dist field during stakeout. If a road definition is defined only as a horizontal alignment, you can only stake it out in two dimensions. The horizontal and vertical alignments of a road do not necessarily start and end at the same stationing. When they do not, you can only stake out points in three dimensions if their stations lie within the horizontal alignment.

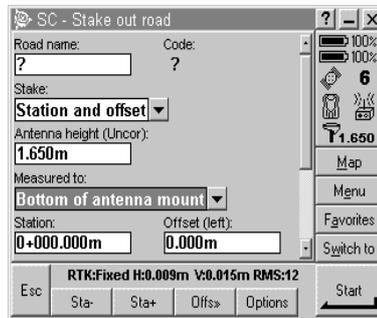
Staking out Points on the Road by Station and Offset

Before staking out a point on the road, read General Procedure, page 308 and page 378, and Stakeout Settings, page 379.

Select a Point on a Road

To do this:

1. From the main menu, select *Survey / Stakeout/Roads*. A screen, similar to the following one, appears:



2. In the *Road name* field, select the road to be staked out. To select a road, access the Road name field and tap **List** to view a list of available roads, and highlight the required road.



Tip – To review the selected road, tap **Review** now. To edit the road, tap **Key in**. Use the *Key in / Road* screen that appears to edit the road.

3. Tap **Enter** to enter the name in the *Road name* field.

The *Code* field displays the code of the offset to be staked out. The Trimble Survey Controller software uses the code from the template definition for the selected offset. When the offset is 0.000 m, the code defaults to CL.



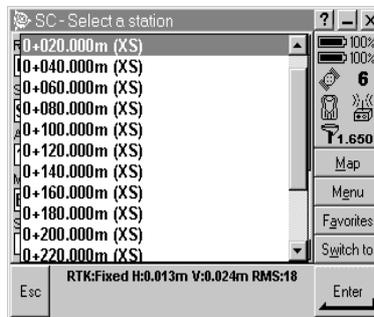
Tip – If you stake out a point and then measure it, you can edit the code in the *Confirm staked deltas* screen. Alternatively, store the point and then select *Files / Review current job* to edit the code. To change the default code for the template element, select either *Key In / Templates* or *Files / Review current job*.

4. In the *Stake* field, select *Station and offset*.
5. Enter a value in the *Antenna/Target height* field and make sure that the *Measured to* field is set correctly. This is especially important when staking out a catch point. The Trimble Survey Controller software can accurately locate the point only if this setting is correct.

Select the Station to be Staked Out

To do this:

1. Do one of the following:
 - Select it from a list. To do this, highlight the *Station* field and tap to display a list of stations. The following screen appears:



The list contains the stations defined by the section interval, and the stations where the horizontal or vertical alignment changes.

Table 6.1 lists the abbreviations that the Trimble Survey Controller software uses.

Table 6.1 Stationing abbreviations

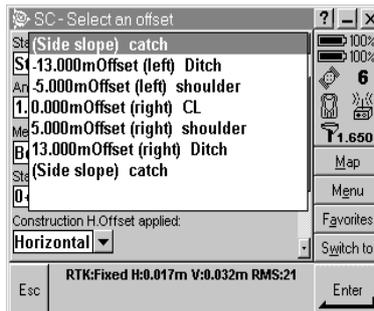
Abbreviation	Meaning	Abbreviation	Meaning
CS	Curve to spiral	SS	Spiral to spiral
PC	Point of curvature (Tangent to curve)	ST	Spiral to tangent
PI	Point of intersection	TS	Tangent to spiral
PT	Point of tangent (Curve to tangent)	VCE	Vertical curve end
RE	Road end	VCS	Vertical curve start
RS	Road start	VPI	Vertical point of intersection
SC	Spiral to curve	XS	Cross-section

- Enter a value. The value must be between the Start station and the End station for the road.
- Tap to select the next station in the list. Tap to select the previous station in the list.

Select the Offset to be Staked Out

To do this:

1. Do one of the following:
 - Select a specific offset from a list. To do this, access the *Offset* field and tap . The following screen appears with a list of all offsets and their codes (if assigned):



In *Key in / Template*, these codes are assigned as part of the template element.

In the RoadLink software, you assign a code in the template definition.

- Enter a value. A negative value for an offset to the left of the centerline; a positive value for an offset to the right.

If you enter a value greater than the maximum offset in the template, a message appears. It warns that the offset is outside the range, and asks if you want to use the left side-slope, or right, depending on the value entered.

If you tap another message appears. It warns that point positions will be in two dimensions, and asks whether you want to continue. This option is useful if you need to stake out the 2D position of a feature not defined in the template (the position of a lamppost, for example).

- Tap **Offs>>** and select an option from the *Offset* menu, which appears in the following screen:

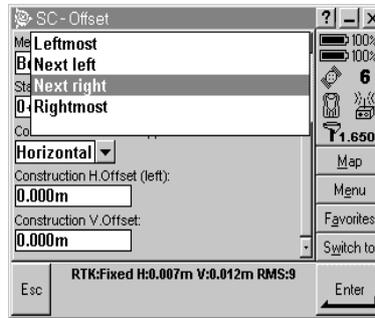


Table 6-2 describes these options.

Table 6-2 Offset menu options

Option	Description
Leftmost	Selects the leftmost template element
Next left	Decrements the offset (selects the previous record in the list of offsets)
Next right	Increments the offset (selects the next record in the list of offsets)
Rightmost	Selects the rightmost template element



Tip – Select an offset from the list, or by using the **Offs>>**. For all subsequent station values, the offset value will be updated to reflect any widening or interpolation.

If you enter an offset value, that value will be maintained for all subsequent station values, even when the entered value corresponds to a value in the list.

Consider Figure 6.1. If you select offset 5 m at station 0 m, the offset value will update to follow the solid line for subsequent stations, moving from offset 5 m to offset 8 m. If you enter 5 m for the offset, the offset will follow the dashed line, maintaining offset 5 m for subsequent stations.

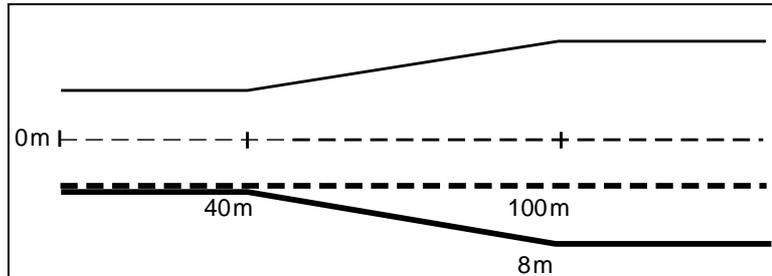


Figure 6.1 Offset Selection

2. If there is a value in the *Construction H.Offset* field, the *Construction H.Offset applied* field specifies how it is applied. Do one of the following:
 - To apply the offset horizontally, select *Horizontal*.
 - To apply the offset at the slope value of the previous template element, select *Slope*.

You cannot apply construction horizontal offsets at the slope value of the previous template element for points with zero offset.

Figure 6.2 shows how the *Horizontal* and *Slope* options are used in the *Construction H.Offset applied* field. The construction *V.Offset* value in the diagram is 0.000.

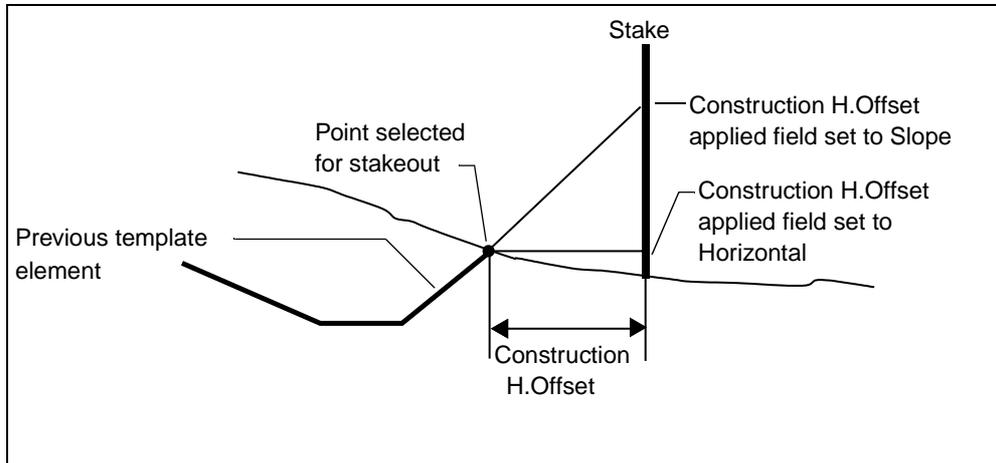


Figure 6.2 Options in the Construction H.Offset applied field

3. If there is a value in the *Construction H.offset* field, the Trimble Survey Controller software directs you to a point that is offset from the design point.

A negative value offsets the point towards the centerline (in).
 A positive value offsets the point away from the centerline (out).

Note – If you enter a value for the *Construction H.Offset* on the centerline (at offset 0.00 m), a negative value offset is to the left.

4. If there is a value in the *Construction V.Offset* field, the Trimble Survey Controller software directs you to a point that is offset vertically from the design point, as follows:
 - A negative value offsets the point vertically down.
 - A positive value offsets the point vertically up.

Note – Construction offsets are not automatically applied to a side-slope offset. For more information, see page 110. Construction offset values specified here are not applied to a DTM surface.

Navigating to a Point on the Road

The navigation process that the Trimble Survey Controller software uses depends on whether you are staking out a non-side-slope point or a side-slope point.

Note – Before navigating to the point in a GPS survey, make sure that the survey is initialized. For more information, see *RTK Initialization Methods*, page 264.

Icons in the graphical display screen

Table 6.3 lists the icons that appear in the top right of the graphical display screen when you stake out a point on a road. (The graphical display screen is shown in the next section.)

Table 6.3 Icons in the graphical display screen

Icon	Information about the point staked out
	The point is on the left side of the road and is in <i>cut</i> . ¹
	The point is on the left side of the road and is in <i>fill</i> . ²
	The point is on the right side of the road and is in <i>cut</i> .
	The point is on the right side of the road and is in <i>fill</i> .

¹ *Cut* means that the elevation of the design point is lower than the current position.

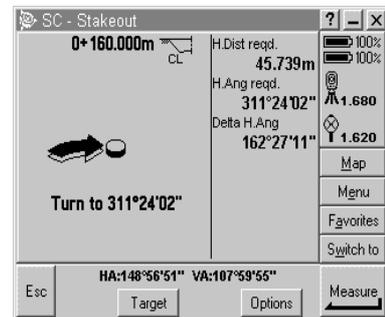
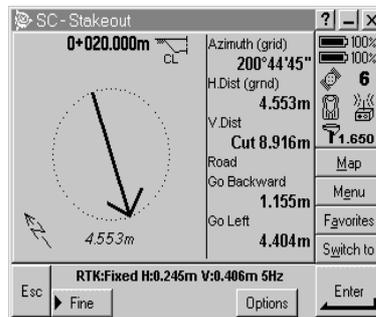
² *Fill* means that the elevation of the design point is higher than the current position

Note – In addition, for side-slope positions the slope value is displayed below the icon. For non-side-slope positions the code (or offset value if no code is assigned) is displayed below the icon.

Navigating to a non-side-slope point

To navigate to a non-side-slope point:

1. Select a point and tap **Start**. The *Stakeout graphical display* screen appears. If you are using a conventional instrument, refer to the screen on the right:



The station value for the point appears at the top of the screen. An icon to the right indicates:

- the side of the road on which the point lies
- whether the point is in cut or fill
- the code (or offset value, if no code is assigned) for the point

For more information, see Table 6.3.

The left side of the screen shows the compass arrow, and the right side of the screen displays values in the following fields. Table 6-4 shows these fields and the equivalent field in a conventional survey.

Table 6-4 Non-side-slope point fields

Field	What it shows	In a conventional survey, this field is replaced by ...
<i>Azimuth</i>	Azimuth to the point.	<i>Go In (or Go Out).</i>
<i>Horizontal Distance</i>	Horizontal distance to the point. This value is also shown at the bottom of the graphical display screen.	<i>Go Left (or Go Right).</i>
<i>Vertical Distance (cut/fill)</i>	Distance between the present position and the design position being staked out.	
<i>Road: Go Forward (or Go Backward)</i>	Distance from the current position to the point, relative to the road. Forward is towards the end station, backward is towards the start station.	
<i>Road: Go Left (or Go Right)</i>	Distance from the current position to the point, relative to the road. If you are facing the end station, "Left" is on your left. ¹	

¹ The forward/backward and right/left values are relative to the cross-section of the point being staked out (see Figure 6.3). They are not relative to the current direction of travel or to the current stationing and they **do not** represent delta stationing and offset values for points on curved sections of the road. If you are using a conventional instrument, the road values only appear after you take a distance measurement.

Figure 6.3 shows an example of the forwards direction and the right direction when staking out a point.

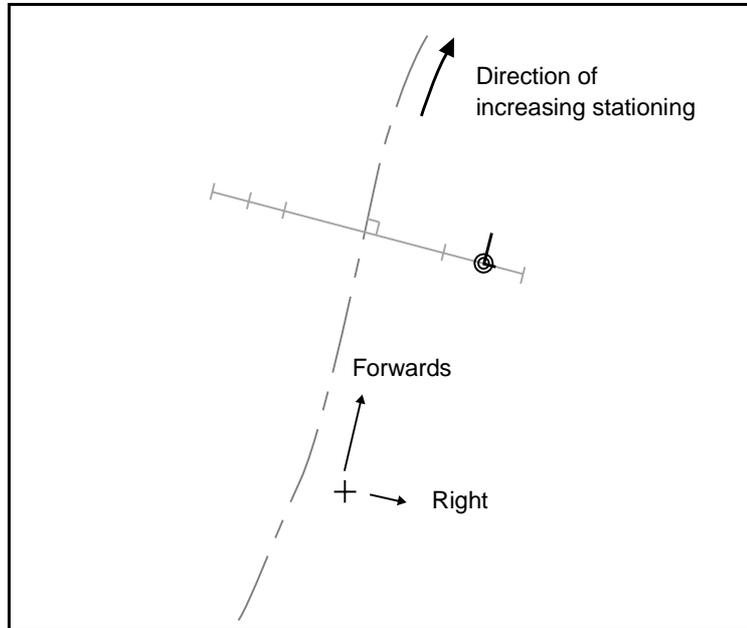


Figure 6.3 Forwards direction and right direction

2. Use the graphical display or the text display to navigate to the point. Do one of the following:
 - If you are using a conventional instrument, see *Using the Graphical Display During Stakeout*, page 381.
 - If you are using GPS, use the arrow as a guide and start moving towards the point, holding the TSCe data collector in front of you. The arrow points in the direction of the point to be staked out. When you walk towards the point, the arrow points to the top of the screen.

Note – *The direction arrow only works correctly when you are moving. Always move forward **towards** the point.*

When you get closer to the point, the arrow disappears. Instead, a bull's-eye symbol represents the point, and a cross represents your position, as shown in the following screen:



Note – When you navigate to a non-side-slope point with construction offsets, the bull's-eye symbol represents the offset point.

3. Tap **Fine** to go into Fine mode. For more information, see Fine and Coarse Modes, page 309.
4. When you are on the point, the cross covers the bull's-eye symbol. Check the precisions and mark the point.

***Note** – The symbol that shows the position of the point also shows the road-space coordinate frame. Figure 6.4 shows how the long line points in the direction of increasing station, while the short line points in the direction (left to right) of increasing offset.*

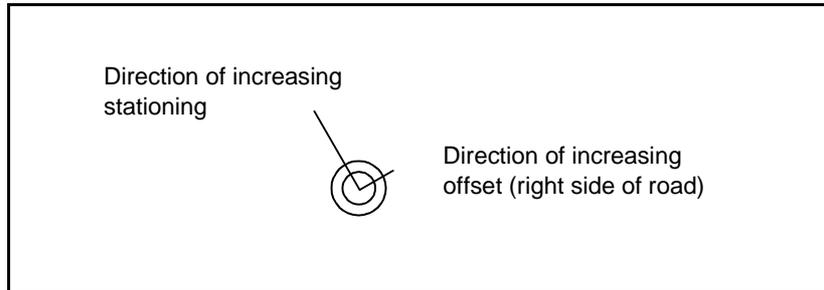


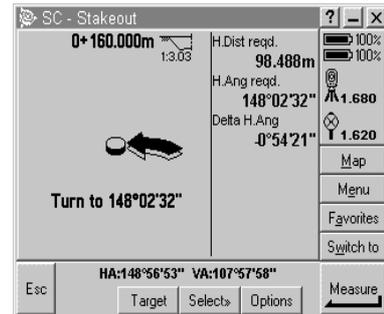
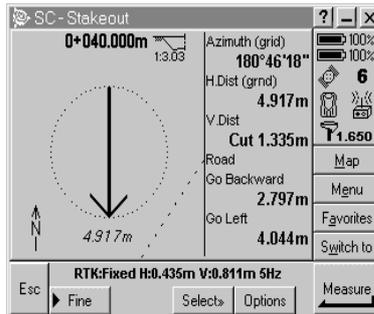
Figure 6.4 Point icon in the graphical display screen

5. Do one of the following:
 - Measure the point. For more information, see *Measuring the As-Staked Position*, page 113.
 - To stake out another point, tap to return to the *Stake out road* screen.

Navigating to a side-slope point

To navigate to a side-slope point:

1. Select a side-slope point and tap **Start**. The Stakeout graphical display screen appears. If you are using a conventional instrument, refer to the screen on the right:



The station value for the point appears at the top of the screen. An icon to the right indicates:

- the side of the road on which the point lies
- whether this is a cut slope or a fill slope
- the slope value of the side-slope

For more information, see Table 6.3, page 102.

Note – For side-slope offsets where the slope changes between templates, the Trimble Survey Controller software calculates the side-slope for intermediate stations by interpolating the slope value.

The screen shows a graphical display and text. The fields that appear are the same as those which appear in the display for a non-side-slope point, as shown on page 103.

Note – Values in the Δ Backward (or Δ Forward) and Δ Left (or Δ Right) fields are relative to the cross-section of the point that is being staked out. They are not relative to the current stationing and **do not** represent delta stationing and offset values for points on curved sections of the road. For more information, see Table 6.3, page 102.

The graphical display also shows a dashed line that connects the side-slope catch position—the point where the side-slope intersects with the ground—to the side-slope hinge position.

2. Tap **Select**>> to select a side-slope option. The following screen appears:

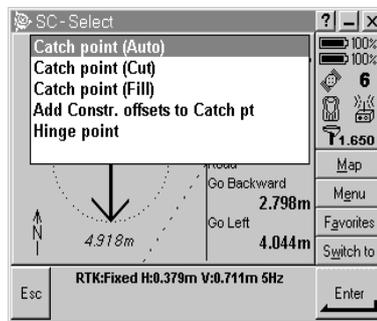


Table 6-5 explains the *Select* menu options for a side-slope.

Table 6-5 Select menu options

Option	Description
Catch point (Auto)	The Trimble Survey Controller software selects the side-slope (cut or fill) to intersect with the ground. This is the default.
Catch point (Cut)	Fixes the side-slope as a cut side-slope.
Catch point (Fill)	Fixes the side-slope as a fill side-slope.

Table 6-5 Select menu options (Continued)

Option	Description
Add Constr. offsets to Catch pt	<p>Applies the horizontal and vertical construction offsets specified to the catch point.</p> <p>Navigate to the catch point before selecting this option. The position of the offset point depends on the catch point, so make sure that you stake out the catch point precisely.</p>
Hinge point	<p>Stakes out the base of the side-slope. This is the most direct way to select the hinge point if the template includes a ditch offset.</p> <p>Note: Construction offsets are not applied to the hinge point when you use this method to select the hinge point.</p>

***Note** – Construction offsets are not automatically applied to a catch point. Navigate to the catch point and then press **Select>>**. Select Add Constr. offsets to Catch pt and navigate to the offset point.*

*There is no need to tap **Select>>** when staking out a catch point with no construction offsets.*

The actual intersection position of the side-slope with the existing ground surface—the catch point—is determined iteratively (by repetition). The Trimble Survey Controller software calculates the intersection of a horizontal plane passing through the current position, and either the cut or fill side-slope, as shown in Figure 6.5, where x_n is the Go Right/Left value.

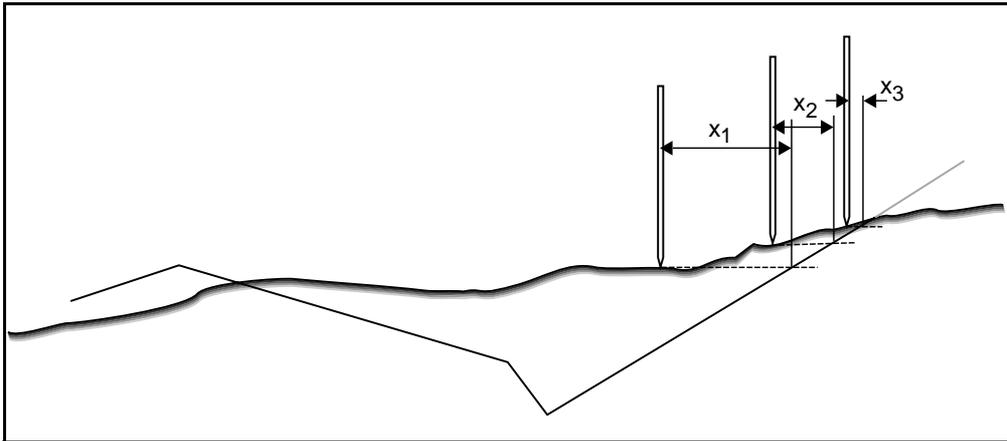


Figure 6.5 Locating a catch point

3. Navigate to the point.
4. Use the graphical display or the text display to navigate to the point. Do one of the following:
 - If you are using a conventional instrument, see *Using the Graphical Display During Stakeout*, page 381.
 - If you are using GPS, use the arrow as a guide and start moving towards the point, holding the TSCe data collector in front of you. The arrow points in the direction of the point to be staked out. When you walk towards the point, the arrow points to the top of the screen.

Note – The direction arrow only works correctly when you are moving. Always move **forwards** towards the point.

When you get closer to the point, the arrow disappears. Instead, a bull's-eye symbol represents the point and a cross represents your position, as shown in the following screen:



The position of the bull's-eye symbol shows the computed position of the catch point.

5. Tap **Fine** to go into Fine mode. For more information, see Fine and Coarse Modes, page 309.

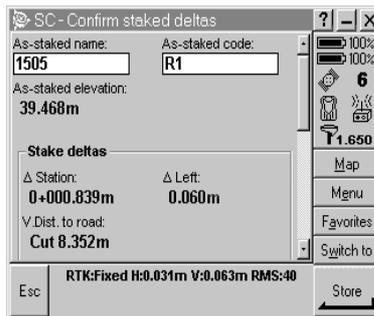
Note – Construction offsets are not automatically applied to a catch point. Navigate to the catch point and then go to Step 2. Select Add constr. offsets to Catch pt and navigate to the offset point.

6. Locate and mark the point, then do one of the following:
 - Measure the point. For more information, see Measuring the As-Staked Position, page 113.
 - To stake out another point, tap **Esc** to return to the Stake out roads screen.

Measuring the As-Staked Position

To measure the as-staked position, locate and mark the point, hold the range pole vertically over the point, and then do the following:

1. In the graphical display screen, tap **Measure**, then do one of the following:
 - In a GPS survey, the *Stake out point* screen appears. Enter a value for the point name and tap **Measure**. The **Store** button appears when enough data has been collected. Tap it to store the point.
 - In a conventional survey, the **Store** button appears. Tap it to store the point.
2. If the *View deltas before storage* check box in the *Stakeout settings* screen is selected, and you are staking out a non-side-slope point, screens similar to those shown below appear:



If you are staking out a side-slope point, screens similar to those shown below appear:

Note – The value in the *S.dist to hinge + Constr off:* field includes any construction offset values specified and reports the slope distance from the hinge to the as-staked position. The value is null (?) if there is no horizontal construction offset specified or the horizontal construction offset is applied horizontally.

Note – The value in the *Design elevation* field and the *H.Offset* field for the design road is null (?) for catch points.



Tip – Tap **Report** to view the *Stake template deltas* screen. It shows the horizontal offset and vertical distance from the catch point to the end of each template element, up to and including the centerline. If the template includes a cut ditch, the report will include the hinge position at the toe of the cut slope. The reported values exclude any construction offset specified.

Figure 6.6 explains some of these fields.

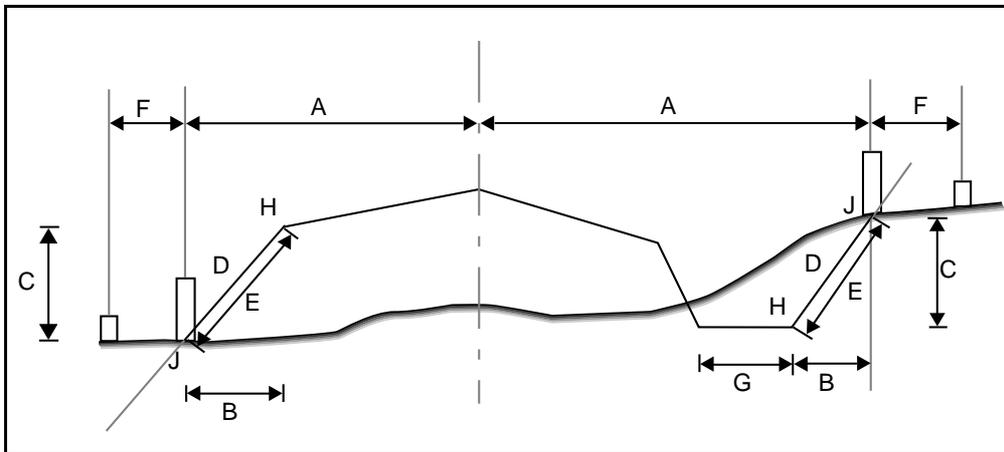


Figure 6.6 Typical cross-section of a road

Where:

- A = Distance to center line
- B = Horizontal distance to hinge point
- C = Vertical distance to hinge point
- D = Slope
- E = Slope distance to hinge point
- F = Construction horizontal offset
- G = Ditch offset
- H = Hinge point
- J = Catch point

3. Tap to store the point.
4. Stake out more points. For more information, see *Staking out Points on the Road by Station and Offset*, page 95.

When there are no more points to stake out, tap to return to the *Survey* menu.

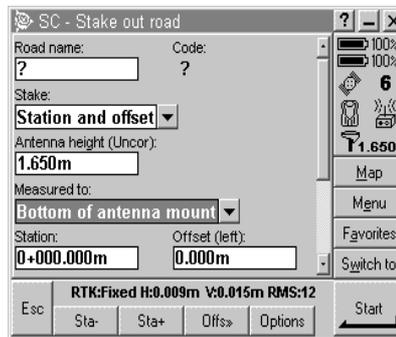
Measuring Positions on the Road

When you use the Trimble Survey Controller software to measure points, it can display your current position on the road.

Determining Current Position Relative to a Road

To determine your current position relative to a road:

1. From the main menu, *Survey / Stakeout / Roads*. The following screen appears:



2. In the *Road name* field, select the road to be staked out.

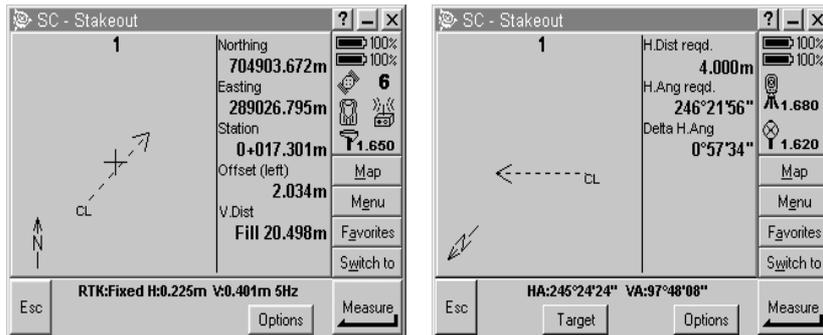
Tip – To select a road, access the *Road name* field and tap to view a list of available roads. Highlight the required road. To review the selected road, tap . To edit the road, tap and use the Key in *Road* screen.

3. In the *Stake* field, select *Position on road*.
4. Enter a value in the *Antenna/Target height* field and make sure that the *Measured to* field is set correctly.
5. If there is a value in the *V.Offset* field, the Trimble Survey Controller software reports your position relative to the design, as adjusted by the specified vertical offset:

- A negative value offsets the design vertically down, a positive value up.

Note – The V.Offset value specified here is not applied to a DTM surface.

6. Tap **Start**. The following screen shows your position relative to the road. If you are using a conventional instrument, refer to the screen on the right:



Note – If you are using a conventional instrument, the road values only appear after you take a distance measurement.

The top of the screen displays the road name. For information about the icons that appear in the top right of the screen, see Table 6.3, page 102. The right side of the screen displays values in the following fields:

- North—the northing coordinate of the current position
- East—the easting coordinate of the current position
- Station—the station value of the current position relative to the road
- Offset (left/right)—the offset value of the current position relative to the road
- V. dist—the vertical distance (cut/fill) of the current position to the road

In the graphical display, shown in Figure 6.7, the road is shown as an icon. It represents a portion of the centerline and shows the direction of increasing stationing. If your current position is more than 25 meters (about 75 feet) from the centerline, the arrow guides you to a position on the centerline. (The software calculates this position by projecting your current position at right angles to the centerline.) If your current position is off the road, that is, your current position is before the start station or beyond the end station of the road, the arrow guides you to the start of the road.

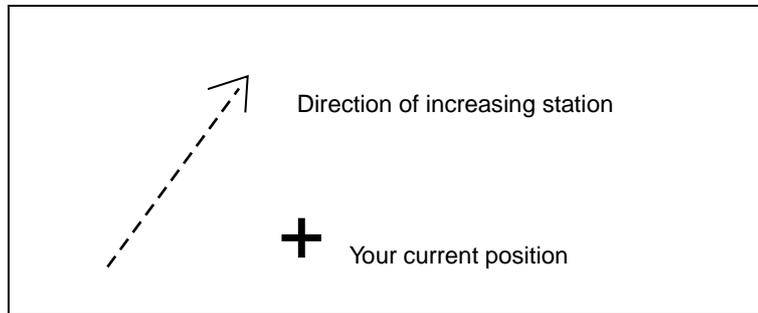


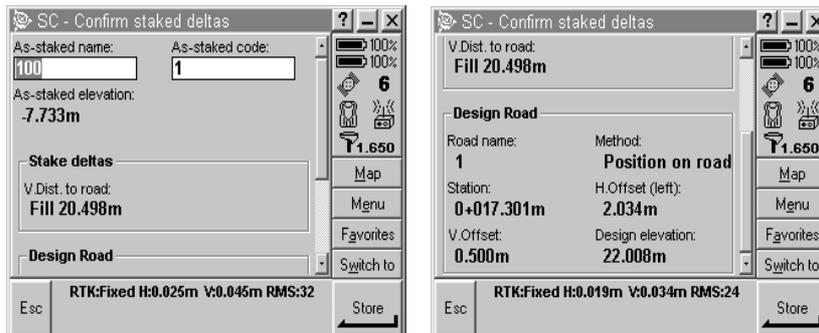
Figure 6.7 Road icon in the graphical display screen

7. Do one of the following:
 - Measure the point. For more information, see the next section.
 - Move to another position on the road and repeat the steps described above.

Measuring Current Position Relative to the Road

To measure the current position relative to the road, do the following:

1. In the graphical display screen, tap **Measure** and then do one of the following:
 - In a GPS survey, the *Stake out point* screen appears. Enter values for the point name and code and tap **Measure**. The **Store** button appears. Tap it to store the point.
 - In a conventional survey, tap **Accept**. The **Store** button appears. Tap it to store the point.
2. If the *View deltas before storage* field in the *Stakeout settings* screen is set to *Yes*, a screen similar to the one shown below appears:



Note – The design elevation excludes any V.Offset specified. If your position is before the start station or after the end station, the Station field displays “Off road”, and the Offset and V.Distance fields display null (“?”). If your position is within the start and end station values but at a greater offset than either the left or right catch points, the Station and Offset fields display the relevant values but the V.Distance field displays null (“?”).

Key In Menu

In this chapter:

- Introduction
- Points
- Lines
- Arcs
- Boundaries
- Roads
- Templates
- Notes

Introduction

The *Key in* menu lets you enter details directly into the Trimble Survey Controller software database without transferring or measuring. Use it to enter notes and to define following: points, lines, arcs, boundaries, roads, and templates.

Note – To set the Distance units for calculations, tap **Options**.

You can also use the *Key in* menu to edit the details of road definitions or points. For information on editing road definitions, see Editing a Definition, page 148.

Points

To key in a point:

1. From the main menu, select *Key in / Points*.
2. Enter values in the *Point name* and *Code* fields.
3. Enter the coordinates for the point. To enter coordinates in another coordinate format, use the **Options** softkey to change the coordinate view to WGS-84, Local, Grid, or ECEF.
4. Specify a search class for the point by selecting or clearing the *Control point* check box. For more information on search classes, see Appendix B, Database Search Rules.
5. Tap **Store** to store the point. The point is stored in the coordinate type you are viewing.
6. Key in more points or tap **Esc** to return to the main menu.



Tip – To key in a point directly from the *Map of current job* screen, tap and hold on the position in the map that you want to add the point to. Then select *Key in point* from the shortcut menu.

Lines

This section shows you how to key in a line in the Trimble Survey Controller software, using one of two methods: Two points or Bearing-distance from a point.

To key in a line:

1. From the main menu, select *Key in / Lines*.
2. Enter values in the *Line name* and *Code* fields.
3. Select an option from the *Method* field and enter the required information. For more information, see *Choosing a Method (Lines)*, page 124.

Note – *The point(s) from which the line is defined must exist in the job database.*

4. Enter the grade for the line. A grade indicates that the line has a slope from the start point. To change the units, highlight the *Grade* field and tap . To define the grade in various ways, tap and change the *Grade* field.
5. For stationing along the line, enter the stationing value for the start point in the *Start station* field. Then enter the distance between stations in the *Station interval* field.
6. To enter ellipsoid distances, tap and set the *Distances* field to Ellipsoid.
7. Tap to calculate the line. The design information is displayed on the screen that appears. It includes azimuth, length, and grade.
8. Tap to store the line in the database.
9. Key in another line or tap to return to the previous screen.

Choosing a Method (Lines)

The following sections describe each method for keying in lines.

Two points

In the *Method* field, select *Two points*, and then enter values in the *Start point* and the *End point* fields.

Alternatively, select the *Start point* and *End point* from the map. Tap and hold on the screen and select *Key in line* from the shortcut menu.

Note – *The height of the two points defines the grade of the line.*

Bearing-distance from a point

To use this method:

1. In the *Method* field, select *Bearing-distance from a point*.
2. As shown in the following diagram, enter the name of the start point (1), the azimuth (2), and the length (3).

Figure 7.1 shows the screen that appears and a graphical representation of this method.

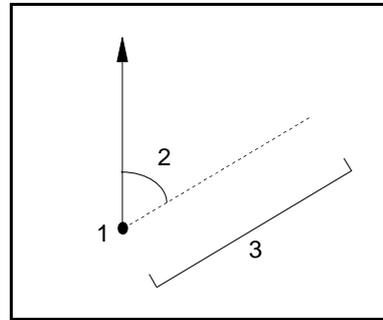
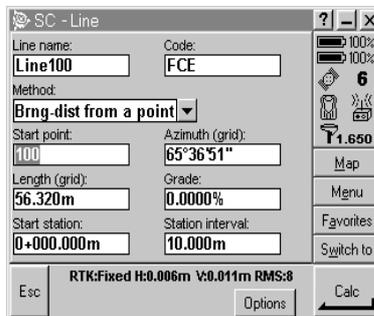


Figure 7.1 Bearing-distance from a point

Arcs

This section shows you how to key in an arc in the Trimble Survey Controller software, using one of these methods: Two points and radius, Delta angle and radius, Arc length and radius, and Intersect point and tangents.

Figure 7.2 explains the terms used to define features of an arc.

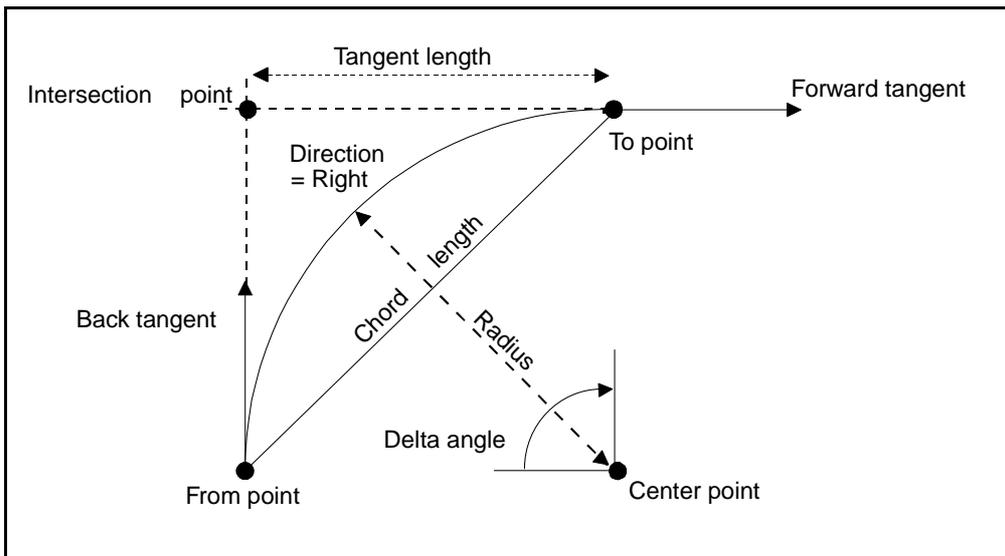


Figure 7.2 Features defining an arc

To key in an arc:

1. From the main menu, select *Key in / Arcs* and then enter values in the *Arc name* and *Code* fields.
2. Select an option from the *Method* field and enter the required information. For more information, see *Choosing a Method (Arcs)*, page 127.

Note – *The point(s) from which the arc is defined must exist in the job database.*

3. If necessary, choose the direction of the arc.

The direction defines whether the arc turns to the left (counterclockwise) or right (clockwise) from the start point. Figure 7.3 shows both a left and right arc.

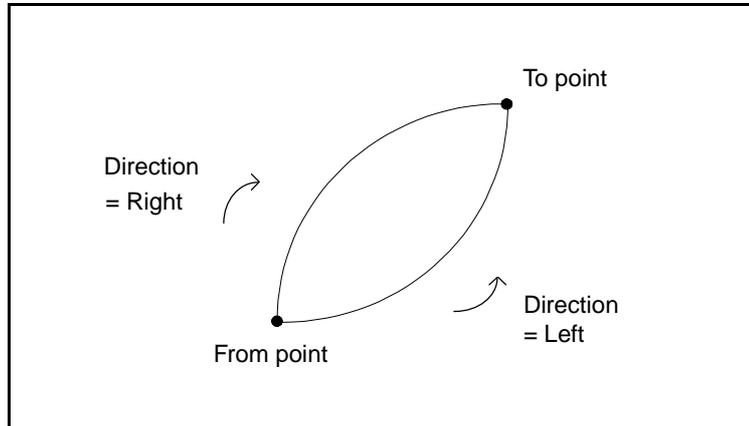


Figure 7.3 Direction of an Arc

4. Enter the grade for the arc. A grade indicates that the arc has a vertical slope from the start point. To change the units, highlight the *Grade* field and tap **Units**. To define the grade in various ways, tap **Options** and change the setting in the *Grade* field.
5. For stationing along the arc, enter the stationing value for the start point in the *Start station* field. Then enter the distance between stations in the *Station interval* field.
6. To enter ellipsoid distances, tap **Options** and select *Ellipsoid* from the *Distances* field.
7. Tap **Calc** to calculate the arc.

The design information is displayed on the screen that appears. It includes:

- back tangent
- forward tangent
- radius

- arc length
 - delta angle
 - chord length
 - tangent length
 - grade
8. Tap to store the arc in the database.
 9. Key in another arc or tap to return to the previous screen.

Choosing a Method (Arcs)

The following sections describe each method for keying in arcs.

Before choosing a method

When defining an arc from a back tangent, make sure that you understand the naming and direction conventions used by the Trimble Survey Controller software.

The back tangent value is related to the direction in which the stationing or chainage increases. For example, when you stand at the intersection point looking in the direction of increasing stationing or chainage, the forward tangent is in front of you and the back tangent is behind you.

Figure 7.4 shows how a back tangent value is related to the direction in which the stationing or chainage increases.

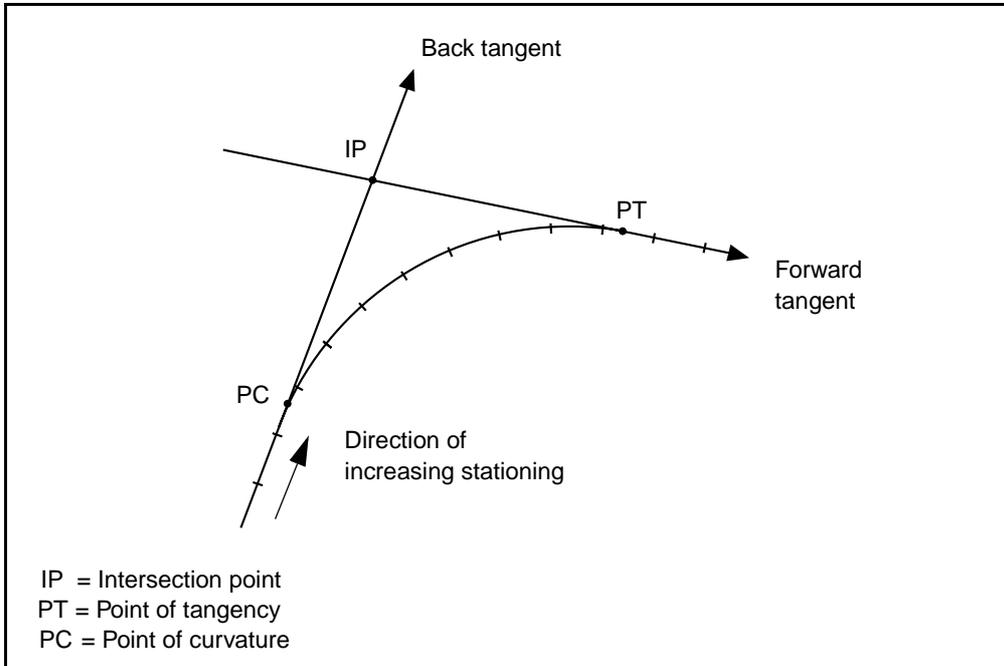


Figure 7.4 Back tangents and forward tangents

Two points and radius

To use this method:

1. In the *Method* field, select *Two points and radius*.
2. As shown in the following diagram, enter the names of the start point (1), and end point (2), and enter the radius (3).

Figure 7.5 shows the screen that appears and a graphical representation of this method.

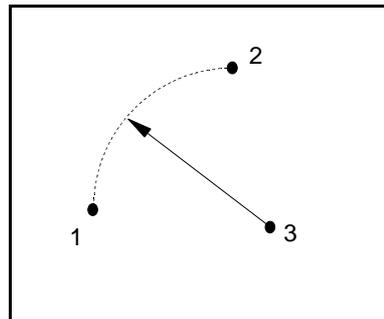
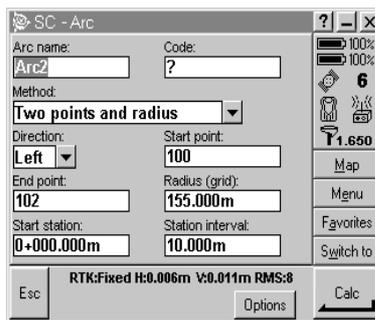


Figure 7.5 Two points and radius

Note – The height of the two points defines the grade of the arc.

Delta angle and radius

To use this method:

1. In the *Method* field select *Delta angle and radius*.
2. As shown in the following diagram, enter the name of the start point (1), the back tangent (2), the radius (3), and the turned angle (4) of the arc.

Figure 7.6 shows the screen that appears and a graphical representation of this method.

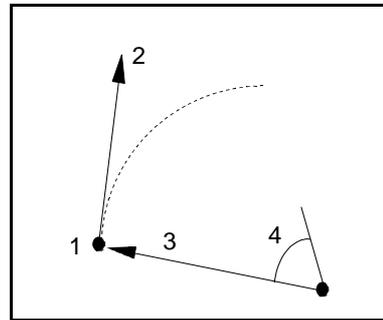
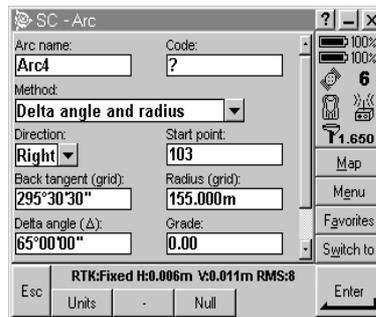


Figure 7.6 Delta angle and radius

Arc length and radius

To use this method:

1. In the *Method* field, select *Arc length and radius*.
2. As shown in the following diagram, enter the name of the start point (1), the back tangent (2), the radius (3), and the length of the arc.

Figure 7.7 shows the screen that appears and a graphical representation of this method.

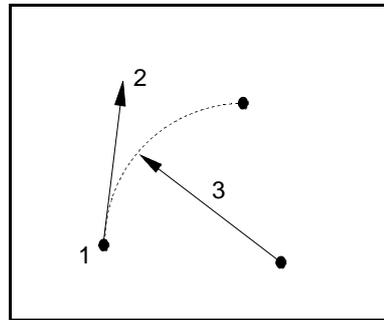
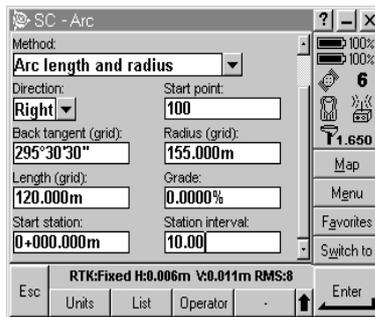


Figure 7.7 Arc length and radius

Intersection point and tangents

To use this method:

1. In the *Method* field select *Intersection point and tangents*.
2. As shown in the following diagram, enter the name of the intersection point (1), the back tangent (2), the forward tangent (3), and the radius(4) of the arc.

Figure 7.8. shows the screen that appears and a graphical representation of this method.

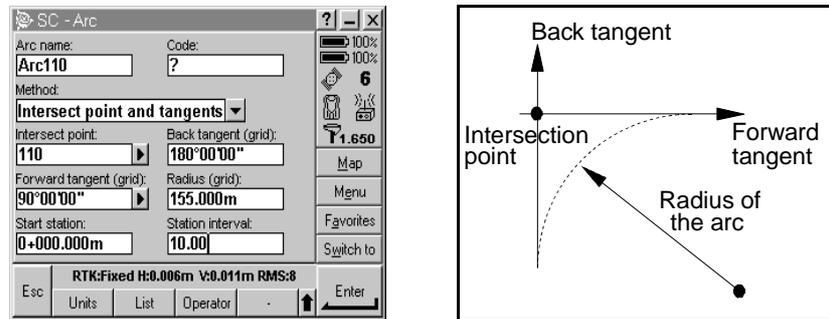


Figure 7.8 Intersection point and tangents

Boundaries

This section shows you how to calculate the coordinates of points on a boundary. You enter a bearing and a distance from an existing point, and the Trimble Survey Controller software calculates the coordinates of the new point. Repeat the steps for the next point on the boundary.

To key in a boundary:

1. From the main menu, select *Key in / Boundary*.
2. As shown in the following diagram, enter the name of the start point (1), the azimuth (2), the horizontal distance (3), and a vertical distance.
3. Enter a name for the intersection point in the *Point name* field.

4. Tap **Calc** to obtain the coordinates of the new point (4).
5. Tap **Store** to store the new point.

The Trimble Survey Controller software returns to the *Boundary* screen and inserts the name of the point just created (4) in the *Start point* field.

6. To compute the misclosure of a circuit of points, give the last point the same name as the first point.
7. Tap **Calc** to obtain the coordinates of the point.
8. When you tap **Store**, the boundary misclosure appears on the screen. Store the last point as a check to avoid overwriting the first point.

Figure 7.9 shows the screen that appears and a graphical representation of this calculation.

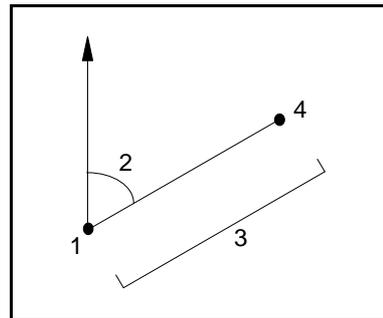
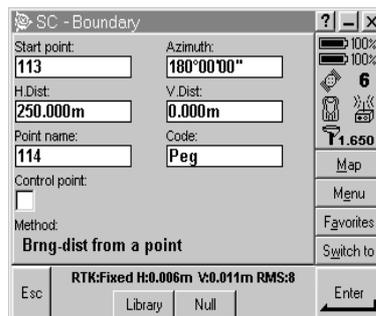


Figure 7.9 Key in boundaries

Roads

This section shows how to key in a road that is defined by a horizontal alignment and (optionally) one or more of the following components:

- vertical alignment
- template positioning
- superelevation and widening records

***Note** – If a road is defined only as a horizontal alignment, it can only be staked out in two dimensions. The horizontal and vertical alignments of a road do not necessarily start and end at the same stationing. When they do not, you can only stake out points in three dimensions if their stations lie within the horizontal alignment.*

To enter a new road definition:

1. From the main menu, select *Key in / Roads*.
2. In the *Name* field, enter a name for the new road definition. Tap .
3. Do one of the following:

- Copy an existing road definition into the current road.

To do this, tap . From the list of available road definitions that appears, highlight the one to be copied and tap . This copies all components comprising that road definition into the current road.



Tip – To view details of a road definition before copying it, highlight the road name and tap . Tap to return to the list or, to view details of other roads in the list, tap or . For more information, see *Reviewing a Definition*, page 147.

- Choose a component to key in, that is, horizontal alignment, vertical alignment, template positioning, and superelevation and widening.

The following sections describe how to key in each component.

Horizontal Alignment

Note – If horizontal alignment is the first component to be keyed in, before you begin, select *Key in / Roads* and provide a name for the road definition. Do this only once for each new road definition.

To add a horizontal alignment to a new road definition, select *Horizontal alignment* and then follow these steps:

1. Tap to enter the first element that defines the alignment. The following screen appears:

The *Element* field is set to *Start point*. You cannot change this.

2. For stationing along the road, enter the stationing value for this start point in the *Start station* field.
3. In the *Method* field, choose one of the following options:
 - Key in coordinates
 - Select point

If you choose the *Key in coordinates* method, enter values in the *Start north* and *Start east* fields.

If you choose the *Select point* method field, enter a value in the *Point name* field. The *Start north* and *Start east* fields will update with the values for the entered point.



Tip – To edit the *Start north* and *Start east* values when they have been derived from a point, change the method to *Key in coordinates*.

4. Enter the distance between the stations in the *Station interval* field. Tap to add the horizontal element.
5. Tap to enter another horizontal alignment element (for example, a line) that defines the road.
6. Select an option from the *Element* field and enter the required information. For more information, see that appropriate section below. Then tap to store the element.
7. When you have entered the last element, tap .



Tip – To delete an element, highlight it and tap . When you add an element, it appears below the previous element that you added. To insert it at a particular place in the list, highlight the element that you want it to follow. Tap and enter details of the element.

8. Enter the other road components or tap to store the road definition.

Line elements

If you select *Line* in the *Element* field, the *Start station* field displays the start station value for the line that you are defining. You cannot edit this.

In the *Azimuth* and *Length* fields, key in values that define the line. If this is not the first line to be defined, the *Azimuth* field displays an azimuth calculated from the previous element. If you edit this and then accept the definition, you are warned that the alignment has non-tangential transitions.

The *End north* and *End east* fields update to display the coordinates at the end of the element just added.

Arc elements

If you select *Arc* in the *Element* field, the *Start station* field displays the start station value for the arc that you are defining. You cannot edit this.

The *Start azimuth* field displays the azimuth as calculated from the previous element. If you edit this, when you accept the definition, you are warned that the alignment has non-tangential transitions.

Table 7.1 shows the available methods and the fields that appear when you select each one.

Table 7.1 Horizontal alignment using arcs

Method	Procedure
Arc length and radius	Specify arc direction. In the <i>Radius</i> and <i>Length</i> fields, enter values that define the arc.
Delta angle and radius	Specify arc direction. In the <i>Angle</i> and <i>Radius</i> fields, enter values that define the arc.
Deflection angle and length	Specify arc direction. In the <i>Angle</i> and <i>Length</i> fields, enter values that define the arc.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Entry spiral/Exit spiral elements

If you select *Entry spiral/Exit spiral* in the *Element* field, the *Start station* field displays the start station value for the entry spiral or exit spiral that you are defining. You cannot edit this.

The *Start azimuth* field displays the azimuth as calculated from the previous element. If you edit this, when you accept the definition, you are warned that the alignment has non-tangential transitions.

In the Arc direction field, select *Right* or *Left*. In the *Radius* field, enter the radius of the arc associated with the spiral. In the *Length* field, enter the length of the spiral.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Note – An exit spiral connecting two arcs is known as a hanging or combining spiral. The end coordinates of the spiral are incorrect until the second arc is added. If you select an entry spiral, the coordinates are correct.

Notes for Keying in and Editing Horizontal Alignments

If you enter non-tangential elements, a warning message appears. If this happens, do one of the following:

- Select *Yes* to adjust the current element to maintain tangency.
- Select *All* to adjust all elements to maintain tangency.
- Select *None* to accept non-tangency for all elements.
- Select *No* to accept non-tangency for the current element.

When you edit an element, the station and coordinate values for all subsequent elements update to reflect the change. All remaining values defining the subsequent elements are maintained. Exceptions to this are as follows:

- If you edit the radius of a spiral or arc, the Trimble Survey Controller software warns you that adjacent spiral/arc elements that define the arc will be updated with the same radius. If this happens, do one of the following:
 - Select *Yes* to adjust the adjacent elements.
 - Select *No* to discard the changes you have made.
- A spiral connecting two arcs (known as hanging or combining spirals) is referred to as an exit spiral when the radius of the second arc is greater than the radius of the first arc. If you edit the radius of the second arc so that it is smaller than the radius of the first arc, the Trimble Survey Controller software changes the spiral to an entry spiral with the radius of the second arc.

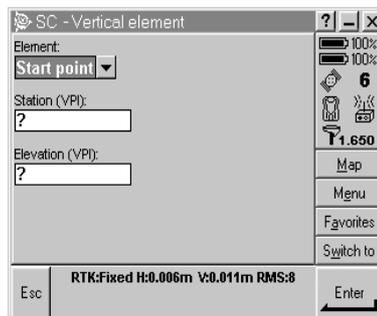
- Similarly, if you edit the radius of the first arc so that it is smaller than the radius of the second arc, the Trimble Survey Controller software changes the spiral to an exit spiral with the radius of the first arc.

Vertical Alignment

Note – If vertical alignment is the first component to be keyed in, select Key in / Roads and provide a name for the road definition before starting. Do this only once for each new road definition.

To add a vertical alignment to a new road definition, select *Vertical alignment* and then follow these steps:

1. Tap **New** to enter the first element that defines the alignment. The following screen appears:



The *Element* field is set to *Start point*. You cannot change this.

2. In the *Station* and *Elevation* fields, key in the values that define the first vertical point of intersection (VPI).
3. Tap **Enter** to add the vertical element record.
4. Tap **New** to enter another vertical alignment element (for example, a circular arc).
5. Select an option from the *Element* field and enter the required information. For more information, see the appropriate section below.

6. When you have entered the last element, tap **Abort**.



Tip – To delete an element, highlight it and tap **Delete**.

7. Enter the other road components or tap **Store** to store the road definition.

Point elements

If you select *Point* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI.

Note – *A vertical alignment must start and end with a point.*



Tip – You can also use points between the start and end points if the alignment changes direction when no parabola or arc is required.

Symmetric parabola elements

If you select *Sym parabola* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the length of the parabola in the *Length* field.

Asymmetric parabola elements

If you select *Asymmetric parabola* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the In and Out lengths of the parabola.

Circular arc elements

If you select *Circular arc* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the radius of the circular arc in the *Radius* field.

Note – *When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.*

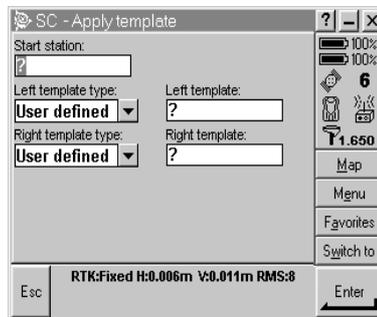
Template Positioning

Note – If template positioning is the first component to be keyed in, before you begin, select *Key in / Roads* and provide a name for the road definition. Do this only once for each new road definition.

Define the position of templates in a road definition by specifying the station at which the Trimble Survey Controller software starts to apply each template. A template is applied at the start station and template element values are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next template is applied.

To define the template positioning:

1. Select *Template positioning*.
2. Tap . The following screen appears:



3. In the *Start station* field, specify the start station for the template(s).
4. The options in the *Left template* and *Right template* fields are as follows:
 - User defined—allows you to select templates for the left side and the right side of the horizontal alignment.
 - <None>—no templates are assigned. Use this option to create a gap in the road definition.
 - <Interpolate>—the template for this station is interpolated from the previous and next templates in the road definition.

5. If you selected *<None>* or *<Interpolate>*, go to the next step. If you selected *User defined*, do one of the following:
 - Select from the list.

To do this, double tap the *Left template* (or *Right template*) field. Tap to display the list of available templates. This list contains templates defined using the *Key in / Templates* command.
 - Enter a template name.

This name must match an existing template name. If the name is invalid, the Trimble Survey Controller software warns you.
Tap and use the screen that appears to key in details for the new template. For more information, see *Templates*, page 144.
6. Tap to apply the templates.
7. Tap to enter more templates at other positions.
8. When all template positions are entered tap .



Tip – To delete a highlighted entry, tap .

9. Enter the other road components or tap to store the road definition.

Superelevation and Widening

Note – If superelevation and widening is the first component to be keyed in, before you begin, select *Key in / Roads* and provide a name for the road definition. Do this only once for each new road definition.

Define where superelevation and widening values are applied in a road definition by specifying the station at which the Trimble Survey Controller software starts to apply them. Superelevation and widening values are applied at the start station, and values are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next superelevation and widening values are applied.

To add superelevation and widening values to a new road definition:

1. Select *Superelevation & widening* and tap . The following screen appears:

2. In the *Start station* field, specify the station where the superelevation and widening starts.
3. In the *Left super* and *Right super* fields, enter superelevation values for the left and right sides of the horizontal alignment.



Tip – To change the way a superelevation value is expressed, tap and change the *Grade* field as required.

4. In the *Pivot* field, specify the position about which the template rotates. The options are *Pivot left*, *Pivot crown*, and *Pivot right*.

5. In the *Left widening* field, enter the widening value to be applied.

This value is applied to each element in the template that has the *Widening* check box selected.

6. Do the same for the *Right widening* field. Tap to add these superelevation and widening values to the road definition.

Note – Widening is expressed as a positive value.

7. To enter more superelevation and widening records tap .
8. After entering the last superelevation and widening record, tap .



Tip – To delete an entry, highlight it and tap .

9. Enter the other road components or tap to store the road definition.

Templates

This section shows you how to enter a template. For information on how to define the position of a template, see *Template Positioning*, page 141.

To enter a template:

1. From the main menu, select *Key in / Templates*.
2. In the *Name* field, enter a name for the new template and tap .
3. Do one of the following:
 - Copy an existing template into the current template. To do this, tap . A list of available template definitions appears. Highlight the one to be copied and tap .



Tip – To view details of a template before copying it, highlight the template name and tap **Review**. Tap **Esc** to return to the list or, to view details of other templates in the list, tap **Prev** or **Next**.

- Manually key in the elements of the new template.

Keying In Elements

To manually key in the elements in a template:

1. Select *Key in / Templates* and name the new template as described above.
2. Tap **New** to enter the first element defining the template.
3. Select an option from the *Element* field and enter the required information. For more information, see the appropriate section below.
4. To add the template element, tap **Enter**.
5. To enter more elements that define this template, tap **New**.
6. When you have entered the last element, tap **Enter**.



Tip – To delete an element, highlight it and tap **Delete**.

7. Tap **Store** to store the template.

Cross fall and offset

If you selected *Cross fall and Offset* in the *Element* field:

1. In the *Cross fall* and *Offset* fields, enter the values that define the element.



Tip – To change the way a cross fall value is expressed, tap **Options** and change the *Grade* field as required.

2. Enter a value in the *Code* field (this step is optional).



Tip – The annotation entered in the *Code* field is assigned to the end of the element and is displayed during stakeout. (For example, the code 'CL' is displayed in the Stakeout screen on page 106.)

3. Select the *Apply superelevation* and *Apply Widening* check boxes as required.

Delta elevation and offset

If you selected *Delta elevation and Offset* in the *Element* field:

1. In the *Delta elevation* and *Offset* fields, enter the values that define the element.
2. Enter a value in the *Code* field (this step is optional).
3. Select the *Apply superelevation* and *Apply Widening* check boxes as required.

Delta elevation only

If you selected *Delta elevation only* in the *Element* field:

1. In the *Delta elevation* field, enter the value that defines the element.
2. Enter a value in the *Code* field (this step is optional).

Side-slope

If you selected *Side-slope* in the *Element* field:

1. In the *Cut slope*, *Fill slope*, and *Cut ditch width* fields, enter the values that define the element.

Note – *Cut and fill slopes are expressed as positive values.*

Figure 7.10 shows the cut ditch width.

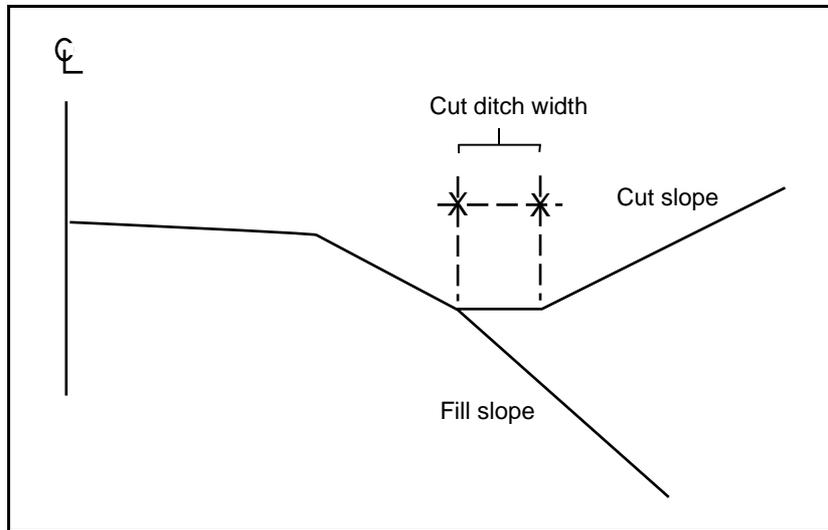


Figure 7.10 Cut ditch width

2. Enter a value in the *Code* field (this step is optional).

Reviewing a Definition

To view the details of an existing road definition select *Key in / Roads*. Double-tap the *Name* field then tap . Highlight the road name and tap . To return to the list tap or, to view details of other roads in the list, tap or .

Use the same process to review a template.

You can also review the details of a road or template component at any time. For more information, see *Reviewing the Database*, page 15. Alternatively, select *Key in / Roads* or *Key in / Templates* (as if to edit the record).

Editing a Definition

Use the *Key in* menu to enter details directly into the Trimble Survey Controller database without transferring or measuring. You can also use this menu to edit (change) the details of a road definition that is imported or keyed in, and to edit a definition that you started to key in but did not complete.

To edit a road definition that was imported from the Trimble RoadLink software or partially keyed in, do one of the following:

- Select *Key in / Roads*.

Note – This is not possible during a survey. End the survey, or see the tip on page 95.

- Select *Key in / Templates* to edit a template definition

To select a road definition for editing, do one of the following:

- Select it from a list

To do this, double-tap the *Name* field. Tap to display a list of available roads.

- Enter the name of the road definition

This name must match an existing road name.

Use the same process when selecting a template definition to edit.

Note – When you edit a road or template definition, a new definition is stored. The original definition stays in the Trimble Survey Controller software database, but the deleted symbol (⊙) indicates that it is no longer available.

Notes

You can enter a note in the Trimble Survey Controller database at any time. To do this:

1. From the main menu, select *Key in / Notes*.
2. Type in the details to be recorded. Alternatively tap  to generate a record of the current time.
3. Tap  to store the note in the database or  to discard it.
4. To exit *Key in notes*, tap . Alternatively, if the *Note* form is empty, tap .

Note – *If a feature code list is already selected for the job, you can use codes from the list when keying in a note. From the Note screen, press  to display the feature code list. Select a code from the list or type the first few letters of the code.*

Cogo Functions

In this chapter:

- Introduction
- Using Cogo functions
- Compute inverses
- Compute intersections
- Compute areas
- Compute azimuths
- Compute distances
- Subdivide lines
- Subdivide arcs
- Traverses

Introduction

The Trimble Survey Controller software provides coordinate geometry (Cogo) functions that perform various calculations using points stored in the database. The results can also be stored in the database. To access these functions, use the *Cogo* menu.



Warning – Do not compute intersection points and then change the coordinate system or perform a calibration. If you do, these points will be inconsistent with the new coordinate system.

Using Cogo Functions

This section outlines the general procedure to follow in order to perform calculations using the Trimble Survey Controller Cogo functions. For detailed instructions on how to use a particular function, see the appropriate section later in this chapter.

To use a Cogo function:

1. From the main menu, choose *Cogo*, then the required Cogo function. If necessary, set the *Method* field.
2. Enter the variables such as point name, line name, distance, or azimuth.
3. Tap to calculate the results.
4. Tap to store the results in the Trimble Survey Controller database (this step is optional).

Embedded Cogo Softkey

A **Cogo** softkey appears when you access some of the fields in the main *Cogo* screen. The softkey applies only to that particular field, and provides a shortcut from the field to a Cogo calculation. Use this embedded **Cogo** softkey to calculate a value for a field in the current *Cogo* screen.

Example

To use the embedded **Cogo** softkey to divide a line into segments of fixed length in the *Subdivide a line* option:

1. If the length is to be the same distance as between points *A* and *B*, access the *Segment length (grnd)* field and tap **Cogo**. The *Compute distance* screen appears.
2. Set *Method* to *Between two points*.
3. Enter the point name *A* in the *From point* field and the point name *B* in the *To point* field.

The computed distance between *A* and *B* is displayed.



Tip – Use the **Prev** and **Next** softkeys to display previous and next calculations.

4. Tap **Enter** to return to the *Subdivide a line* screen. The distance just calculated is inserted into the *Segment length (grnd)* field.

Entering Feature (Points, Lines, Arcs) Names

When entering feature names into fields, select the feature(s) from the map then select the Cogo function. The selected feature(s) are automatically entered into the appropriate fields.

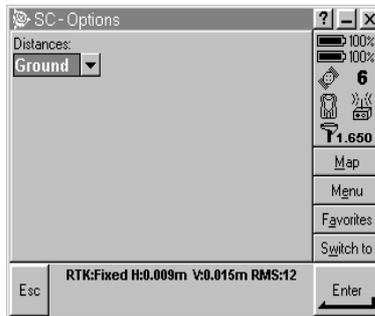
To enter another feature name, do one of the following:

- Tap **Map** and select the features as required. Tap **Esc** to return back to the Cogo screen.

- Tap the map selection button  to access a list of features already selected in the map.
- Access the feature name field and tap  to select features from the database list.
- Tap  to key in details, or  to measure a point.

Options Softkey

Tap  to display the *Options* screen:



Note – The  softkey in the *Traverse* screen contains different options to those shown here. For more information, see *Traverse options*, page 341.

In the *Distances* field, set the type of distance to be calculated. Tap  to change this at any time. For example, to apply an approximate sea level correction, set the *Distances* field in this screen to *Ellipsoid*. These are illustrated in Figure 3.2. page 62.

Note – The *Trimble Survey Controller* software can only display grid distances between points if you defined a projection and datum transformation, selected *Scale factor* only, or keyed in the points as *grid points*.

Multiple Solutions

For some computations, there are two solutions. Tap Other to display the other solution.

Note – If the Trimble Survey Controller software is configured to operate with quadrant bearings, substitute bearing for azimuth in the rest of this chapter.

Compute Inverses

To calculate the azimuth and distance between two points, do one of the following:

- As shown in the following diagram, from the map, select the *From* point (1) and the *To* point (2). Tap and hold on the screen and select the *Compute Inverse* option from the shortcut menu.
- Select *Cogo / Inverse* from the main menu and enter names in the *From point* and *To point* fields.

The computed azimuth (3), horizontal distance (4), change in elevation, and slope distance are displayed.

Figure 8.1 shows the screen that appears and a graphical representation of this method.

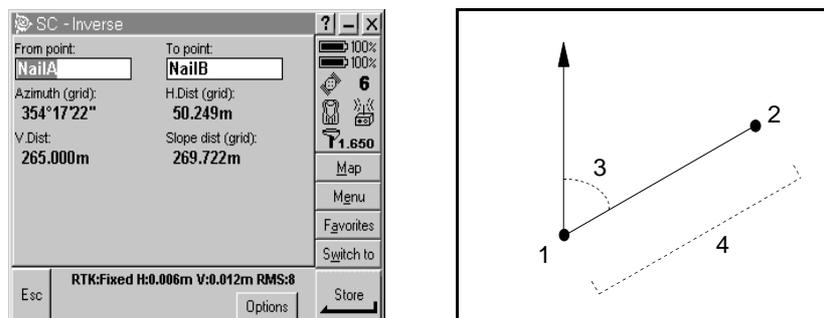


Figure 8.1 Compute inverse

Compute Intersections

The Trimble Survey Controller software can calculate the coordinates of an intersection point from a combination of azimuths and/or distances from existing points.

To calculate an intersection:

1. From the main menu, select *Cogo / Intersections*.
2. Enter a name for the intersection point in the *Point name* field, select an option from the *Method* field and enter the required information.

Choosing a Method (Intersections)

The following sections describe each method for computing intersections.

Bearing-distance intersection

To use this method:

1. Select *Brng-dist intersect* in the *Method* field
2. As shown in the following diagram, enter the name of Point 1 (1), the azimuth (2), the name of Point 2 (3), and the horizontal distance (4).
3. Tap **Calc** to calculate the intersection points (5 and 6). There are often two solutions for this calculation. Tap **Other** to see the second solution.

Figure 8.2 shows the screen that appears and a graphical representation of this method.

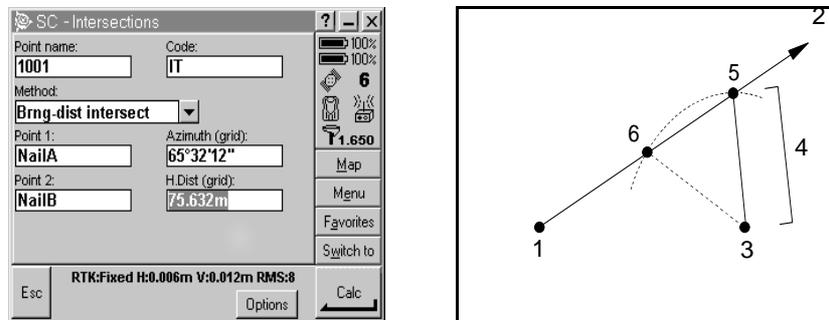


Figure 8.2 Bearing-distance intersection

Bearing-bearing intersection

To use this method:

1. Select *Brng-brng intersect* in the *Method* field.
2. As shown in the following diagram, enter the name of Point 1 (1) and the azimuth (2). Enter the name of Point 2 (3) and the azimuth (4).
3. Tap **Calc** to calculate the intersection point (5).

Figure 8.3 shows the screen that appears and a graphical representation of this method.

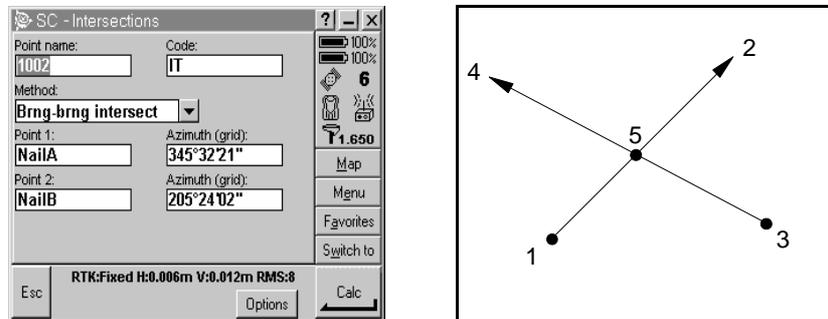


Figure 8.3 Bearing-bearing intersection

Distance-distance intersection

To use this method:

1. Select *Dist-dist intersect* in the *Method* field.
2. As shown in the following diagram, enter the name of Point 1 (1) and the horizontal distance (2). Enter the name of Point 2 (3) and the horizontal distance (4).
3. Tap **Calc** to calculate the intersection points (5 and 6). There are two solutions for this calculation. Tap **Other** to see the second solution.

Figure 8.4 shows the screen that appears and a graphical representation of this method.

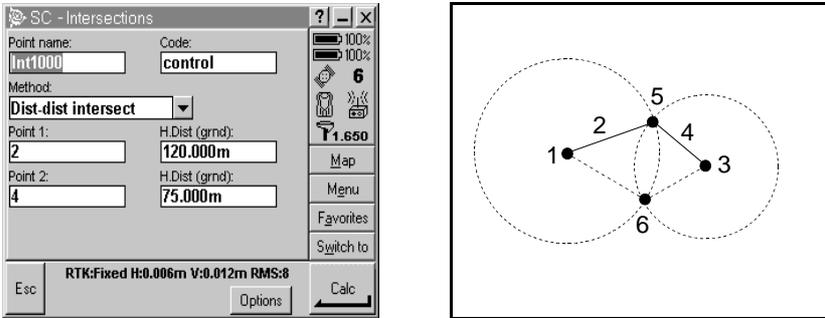


Figure 8.4 Distance-distance intersection

Bearing-distance from a point

To use this method:

1. Select *Brng-dist from a point* in the *Method* field.
2. As shown in the following diagram, enter the name of the start point (1), the azimuth (2), and the horizontal distance (3).
3. Tap **Calc** to calculate the intersection point (4).

Figure 8.5 shows the screen that appears and a graphical representation of this method.

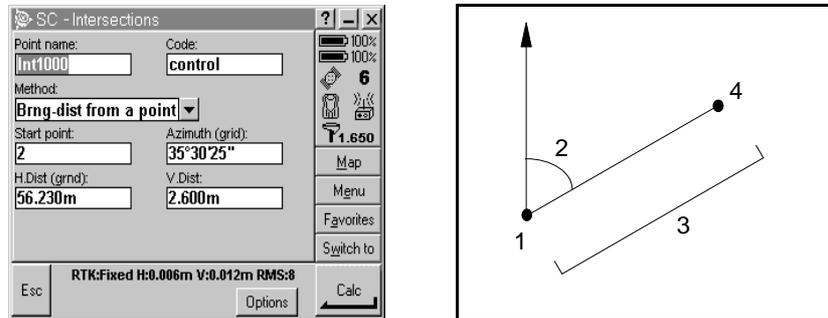


Figure 8.5 Bearing-distance from a point

Compute Areas

The Trimble Survey Controller software can calculate the area enclosed by three or more points selected from its database. It can use up to 100 points.

To compute an area:

1. Do one of the following:
 - From the map, select the points on the perimeter of the area to be calculated. Tap and hold on the screen and select *Compute area* from the shortcut menu.
 - From the main menu, select *Cogo / Compute area*. Select the points on the perimeter of the area to be calculated.

As shown in the following diagram, the calculated area (1) and perimeter (2) are displayed.

Note – Select points in the order in which they occur on the perimeter.

2. Tap **Options** if you need to change the units.
3. Tap **Store** to store the area result in the Trimble Survey Controller software database.

The computed area varies according to the *Distance* display setting. Table 8.1 shows the effect of the distance setting on the area calculated.

Table 8.1 Distances setting options

Distances setting	Computed area
Ground	At the average ground elevation
Ellipsoid	On the ellipsoid surface
Grid	Directly off the grid coordinates

Figure 8.6 shows the *Compute area* calculation and a graphical representation of this method.

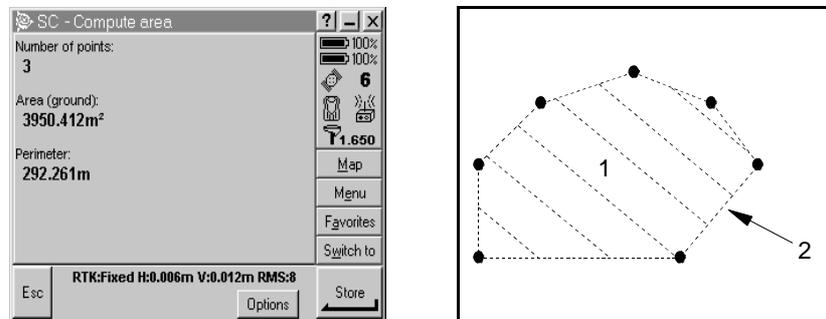


Figure 8.6 Compute area calculation

Compute Azimuths

The Trimble Survey Controller software can calculate an azimuth by various methods, using data that you enter and points in the database. The data that you enter can have different units. For example, you can add an angle in degrees to an angle in radians—the answer is returned in whatever format you specified in the job configuration.

To calculate an azimuth:

1. From the main menu, select *Cogo / Compute azimuth*.
2. Select an option from the *Method* field and enter the required information.

Choosing a Method (Azimuths)

The following sections describe each method for computing azimuths.

Between two points

To compute an azimuth using this method, select *Between two points* in the *Method* field, and then enter the names of the *From* point and the *To* point. The azimuth is calculated.

Bisected azimuths

To use this method:

1. In the *Method* field, select *Bisected azimuths*.
2. As shown in the following diagram, enter the first azimuth (1) and the second azimuth (2). The azimuth (3) halfway between them is calculated.

Figure 8.7 shows the screen that appears and a graphical representation of this method.

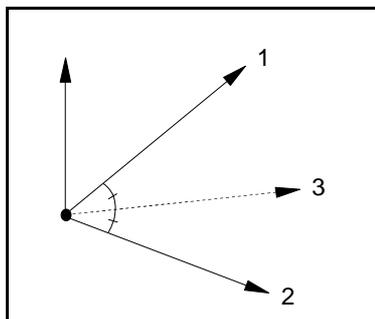
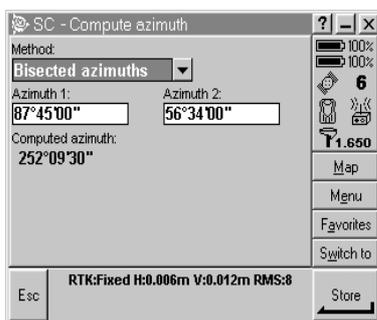


Figure 8.7 Bisected azimuths

Bisected corner

To use this method:

1. In the *Method* field, select *Bisected corner*.
2. As shown in the following diagram, enter the names of Side-point 1 (1), the corner point (2), and Side point 2 (3). The azimuth from the corner point is calculated (4). It is halfway between Side point 1 and Side point 2.

Figure 8.8 shows the screen that appears and a graphical representation of this method.

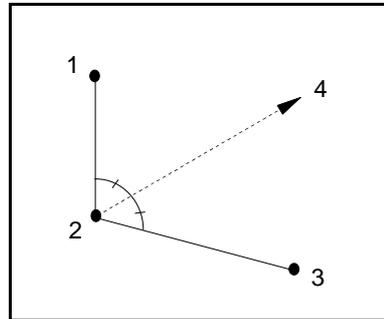
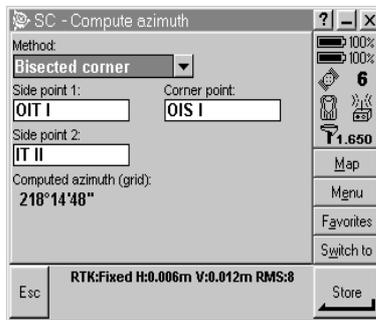


Figure 8.8 Bisected corner

Azimuth plus angle

To use this method:

1. In the *Method* field, select *Azimuth plus angle*.
2. As shown in the following diagram, enter the azimuth (1) and the turned angle (2). The sum of the two is calculated (3).

Figure 8.9 shows the screen that appears and a graphical representation of this method.

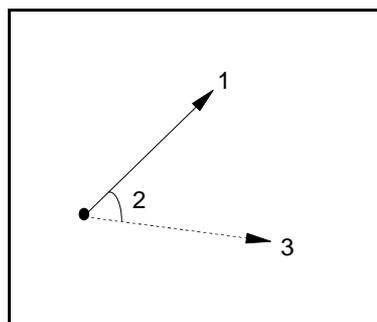
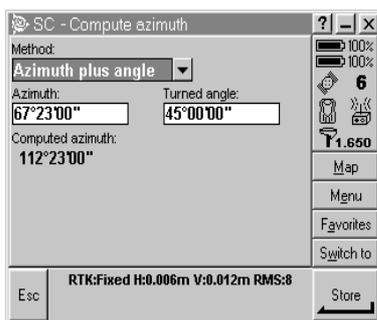


Figure 8.9 Azimuth plus angle

Azimuth to line offset

To use this method:

1. In the *Method* field, select *Azimuth to line offset*.
2. As shown in the following diagram, enter the name of the line (1), the station value (2), and the horizontal offset (3). The azimuth (4) from the start station of the line to the offset point is calculated.

Figure 8.10 shows the screen that appears and a graphical representation of this method.

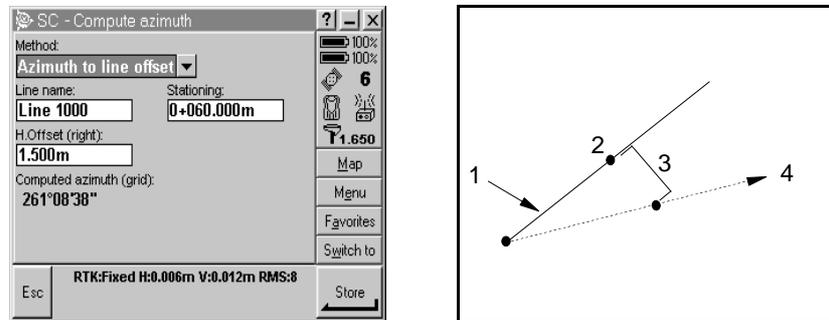


Figure 8.10 Azimuth to line offset

Compute Distances

Use the Trimble Survey Controller software to calculate a distance by various methods, using data that you enter, and points in the database. The data that you enter can have different units. For example, if you add a distance in meters to a distance in feet, the answer is returned in whatever format you specified in the job configuration.

To calculate a distance:

1. From the main menu, select *Cogo / Compute distance*.
2. Select an option from the *Method* field and enter the required information.

Choosing a Method (Distances)

The following sections describe each method for computing distances.

Between two points

To compute a distance using this method, select *Between two points* in the *Method* field, and then enter the *From* point and the *To* point. The distance between them is calculated.

Between point and line

To use this method:

1. In the *Method* field, select *Between point and line*.
2. As shown in the following diagram, enter the names of the point (1) and the line (2). The Trimble Survey Controller software calculates the distance along the line (3) and the perpendicular distance to the line (4). The distance along the line is from the From point (5).

Figure 8.11 shows the screen that appears and a graphical representation of this method.

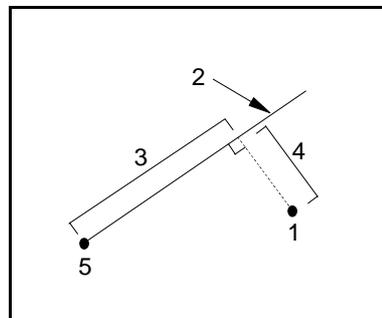
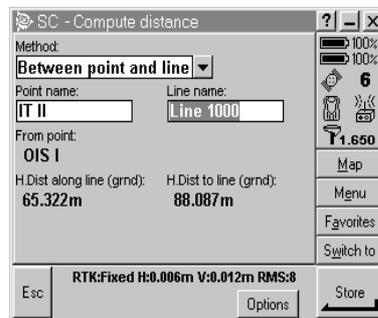


Figure 8.11 Between point and line

Between point and arc

To use this method:

1. In the *Method* field, select *Between point and arc*.
2. As shown in the following diagram, enter the names of the point (1) and the arc (2). The Trimble Survey Controller software calculates the distance along the arc (3) and the perpendicular distance to the arc (4). The distance along the line is from the From point (5).

Figure 8.12 shows the screen that appears and a graphical representation of this method.

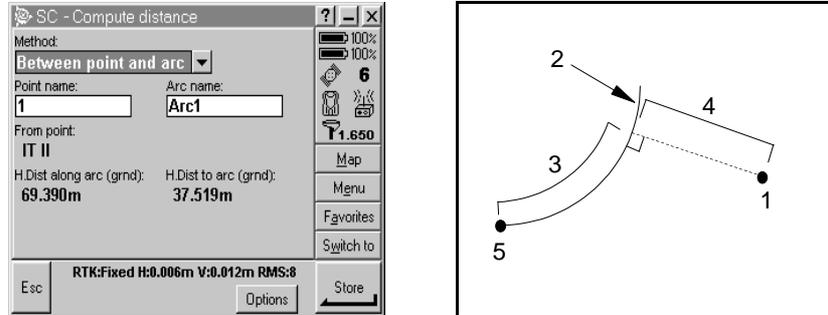


Figure 8.12 Between point and arc

Divided distance

To compute a distance using this method, in the *Method* field, select *Divided distance*, and then enter values in the *Distance* and the *Divisor* fields. The distance of a segment is calculated.

Multiplied distance

To compute a distance using this method, in the *Method* field, select *Multiplied distance*, and then enter values in the *Distance* and the *Multiplier* fields. The total distance is calculated.

Added distances

To compute a distance using this method, in the *Method* field, select *Added distance*, and then enter values in the *Distance 1* and *Distance 2* fields. The sum of both distances is calculated.

Subdivide Lines

The Trimble Survey Controller software can divide a defined line into segments of fixed length or a fixed number of segments. New points are created along the line.

You can predefine the code of a subdivided point. For more information, see *Subdivide Pts Code*, page 66.

To subdivide a line:

1. Do one of the following:
 - From the map, select the line to be subdivided. Tap and hold on the screen and select the *Subdivide a line* option from the shortcut menu.
 - From the main menu, select *Cogo / Subdivide a line*. Enter the name of the line.
2. Select an option from the *Method* field and enter the required information.

Note – When you enter the name of a defined line, the default value for the *Start at station* field is set to zero, and the default value for the *End at station* field is set to the length of the line. Points created in this way can be used during stakeout.

Choosing a Method (Lines)

The following sections describe each method for subdividing lines.

Fixed segment length

To use this method:

1. In the *Method* field, select *Fixed length segment*.
2. As shown in the following diagram, enter the segment length (2), and a horizontal offset (3) and vertical offset from the line. Enter the start station position (4) on the line, the end station position (5), and the name of the start point that will be incremented automatically.
3. Tap to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:
Subdivision of line completed successfully
4. Tap to continue. Points are automatically stored in the database.

Figure 8.13 shows the screen that appears and a graphical representation of this method.

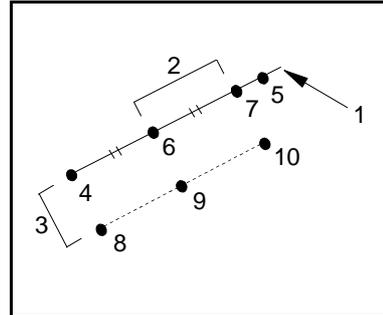
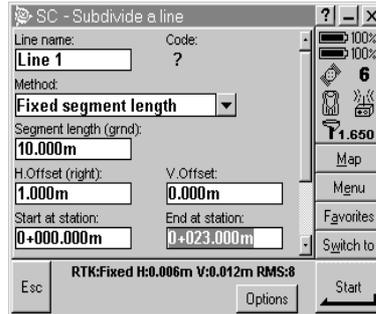


Figure 8.13 Fixed segment length

Note – If the defined line is longer than an integer number of segments, the last subdivided point (Point 7 in this example) is the end of the last full segment.

Fixed number of segments

To use this method:

1. In the *Method* field, select *Fixed number of segments*.
2. As shown in the following diagram, enter the number of segments, and a horizontal offset (2) and vertical offset from the line. Enter the start station position (3) on the line, the end station position (4), and the name of the start point that will be incremented automatically.
3. Tap **Start** to calculate the new points (3, 5, 4 or 6, 7, 8). When the operation is completed, the following message appears:
Subdivision of line completed successfully
4. Tap **OK** to continue. The points are automatically stored in the database.

Figure 8.14 shows the screen that appears and a graphical representation of this method.

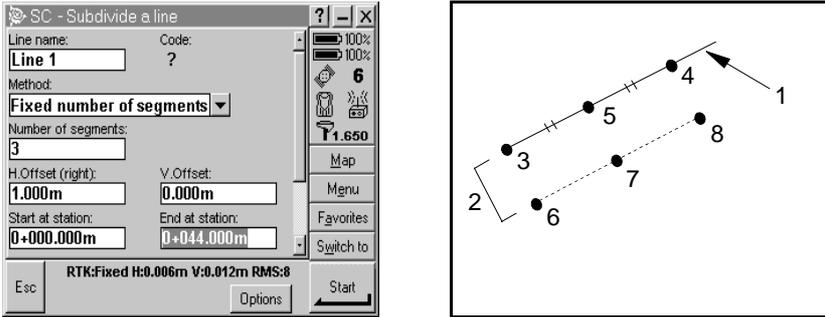


Figure 8.14 Fixed number of segments

Subdivide Arcs

The Trimble Survey Controller software can divide a defined arc into segments of fixed length or a fixed number of segments. New points are created along the arc.

You can predefine the code of a subdivided point. For more information, see *Subdivide Pts Code*, page 66.

To subdivide an arc:

1. Do one of the following:
 - From the map, select the arc to be subdivided. Tap and hold on the screen and select the *Subdivide an arc* option from the shortcut menu.
 - From the main menu, select *Cogo / Subdivide an arc*. Enter the name of the defined arc.
2. Select an option from the *Method* field and enter the required information.

Note – *When you enter the name of a defined arc, the default value for the Start at station field is set to zero, and the default value for the End at station field is set to the length of the arc.*

Choosing a Method (Arcs)

The following sections describe each method for subdividing arcs.

Note – *You can use the points created using the Subdivide an arc option in the Stakeout screen.*

Fixed segment length

To use this method:

1. In the Method field, select *Fixed segment length*.
2. As shown in the following diagram, enter the segment length (2), and a horizontal offset (3) and vertical offset from the arc. Enter the start station position (4) on the arc, the end station position (5), and the name of the start point that will be incremented automatically.
3. Tap **Start** to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:
Subdivision of arc completed successfully
4. Tap **OK** to continue. Points are automatically stored in the database.

Figure 8.15 shows the screen that appears and a graphical representation of this method.

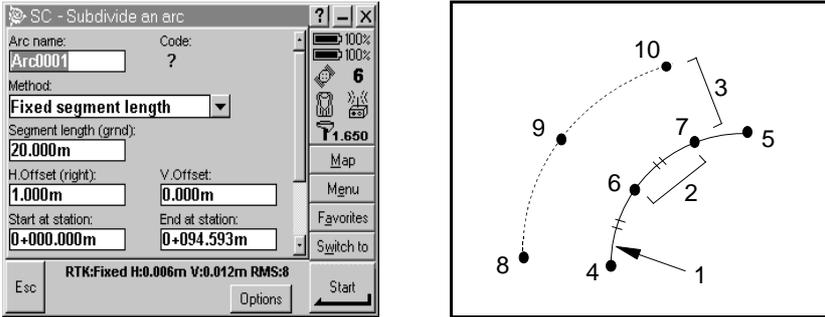


Figure 8.15 Fixed segment length

Fixed number of segments

To use this method:

1. In the *Method* field, select *Fixed number of segments*.
2. As shown in the following diagram, enter the number of segments, and a horizontal offset (2) and vertical offset from the arc. Enter the start station position (3) on the arc, the end station position (4), and the name of the start point that will be incremented automatically.
3. Tap **Start** to calculate the new points (3, 5, 4 or 6, 7, 8). When the operation is completed, the following message appears:
Subdivision of arc completed successfully
4. Tap **OK** to continue. The points are automatically stored in the database.

Figure 8.16 shows the screen that appears and a graphical representation of this method.

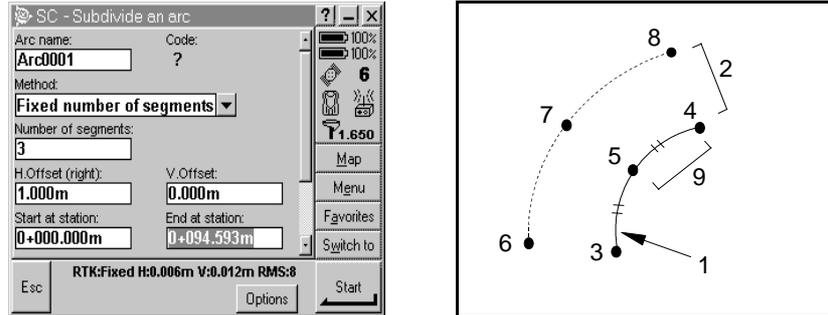


Figure 8.16 Fixed number of segments

Fixed chord length

To use this method:

1. In the *Method* field, select *Fixed chord length*.
2. As shown in the following diagram, enter the chord length (2), and any horizontal offset (3) and vertical offset from the arc. Enter the start station position (4) on the arc, the end station position (5), and the name of the start point that will be incremented automatically.
3. Tap **Start** to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:
Subdivision of arc completed successfully
4. Tap **OK** to continue. Points are automatically stored in the database.

Figure 8.17 shows the screen that appears and a graphical representation of this method.

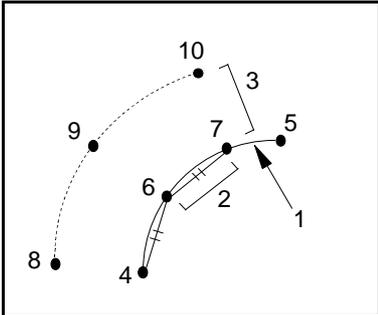
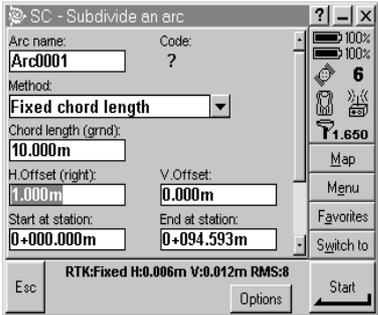


Figure 8.17 Fixed chord length

Fixed angle subtended

To use this method:

1. In the *Method* field, select *Fixed angle subtended*.
2. As shown in the following diagram, enter the subtended angle (2), and a horizontal offset (3) and vertical offset from the arc. Enter the start station position (4) on the arc, the end station position (5), and the name of the start point that will be incremented automatically.
3. Tap to calculate the new points (4, 6, 7 or 8, 9, 10). When the operation is completed, the following message appears:
Subdivision of arc completed successfully
4. Tap to continue. The points are automatically stored in the database.

Figure 8.18 shows the screen that appears and a graphical representation of this method.

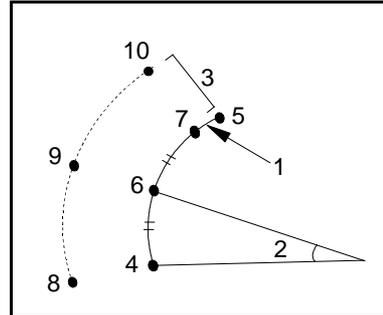
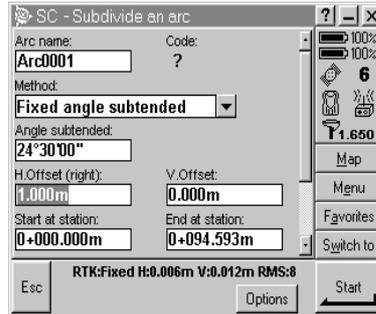


Figure 8.18 Fixed angle subtended

Traverses

The Trimble Survey Controller software can calculate a closure and adjust a traverse. The software helps you to select the points to be used, calculates the misclosure, and then lets you compute either a Compass or Transit adjustment.

Note – The Compass adjustment is sometimes known as the Bowditch adjustment.

You can calculate closed-loop traverses (traverses that start and end on the same point), and traverses that start and end on pairs of known points.

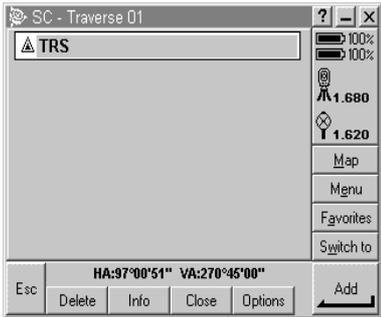
To calculate a traverse:

1. From the main menu, select *Cogo / Traverse*. The *Traverse* screen appears.
2. Enter the traverse name.
3. In the *Start station* field, enter the name of the first point in the traverse. The software only lets you enter a point that has conventional observations from it (an instrument point).



Tip – Tap to see a list of valid points that can be used as the start station.

4. Tap . The following screen appears. The start station point name is the only point in the list:



5. Tap to add the next point in the traverse. The *Select station to add* list appears. The list only displays valid points that can be added. For example, it only displays points that have been used as instrument points **and** have been measured (using a conventional instrument) from the previous point in the traverse list.

Note – When there is only one valid point to add, the Trimble Survey Controller software adds it to the traverse list automatically.

6. Select the next station in the traverse.

Note – To view the observed azimuth and distance between two points in the list, highlight the first point and tap .

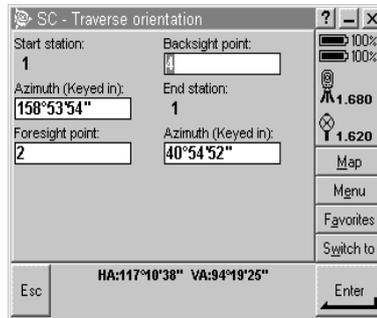
7. Repeat steps 5 and 6 until all the points in the traverse have been added. If you need to remove any points from the list, highlight the point and tap . When you delete a point, all points after it are deleted as well.

Note – You cannot add more points after selecting a control point.

Note – To compute a traverse closure, there must be at least one distance measurement between successive points in the traverse list.

When all of the points have been added:

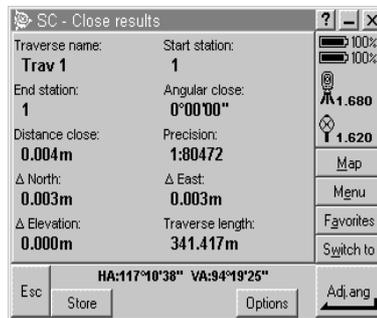
1. Tap **Close**. The following screen appears, showing the backsight and foresight points that provide orientation for the traverse:



2. The *Backsight point*, *Azimuth*, *Foresight point*, and *Azimuth* fields are filled in by the Trimble Survey Controller software. Edit these fields if necessary.

Note – The *Azimuth* fields do not have to be completed. If the *backsight azimuth* is null, the traverse cannot be oriented and adjusted coordinates cannot be stored. The *foresight azimuth* may be null in a loop traverse, and if all angles have been observed, you can compute an angular and distance adjustment. An angular and distance adjustment cannot be computed on an open traverse if the *backsight azimuth* is null. An angular adjustment cannot be computed on an open traverse if the *backsight azimuth* is null. However, a distance adjustment can be computed.

3. Tap **Enter**. The following screen appears:



4. Inspect the results of the traverse and do one of the following:
- To store the closure results, tap **Store**.
 - To return to the *Orientation* screen, tap **Esc**.
 - To adjust the traverse, go to the next step.
5. Tap **Options**. Check the settings in the *Traverse options* screen that appears. For more information about the settings, see *Traverse options*, page 341.

When the settings are complete, tap **Enter** to return to the *Close results* screen.

6. To adjust the angular misclosure in the traverse, tap **Adj.ang**. The angular misclosure is distributed according to the setting in the *Options* screen. The *Adjustment results* screen appears and it shows the distance misclosure.

Note – The **Adj.ang** button does not appear if the angular adjustment method in the *Options* screen is set to *None*.

7. Inspect the results of the traverse and do one of the following:
- To store the angular adjustment details, tap **Store**.
 - To adjust the distance misclosure, tap **Adj.ang**. The distance misclosure is distributed according to the setting in the *Options* screen and the traverse is stored.

When the traverse is stored, each point used in the traverse is stored as an adjusted traverse point with a search classification of control. If there are any previously adjusted traverse points of the same name, they are deleted.

Offsets

In this chapter:

- Introduction
- Generating offsets

Introduction

A GPS antenna or conventional instrument target cannot always occupy a point directly, for example, if a point is the center of a tree or part of a building that is under a canopy. There are several ways to measure these points using the Trimble Survey Controller software. You can use a conventional instrument and measure a point using an offset method. For more information, see page 186. Alternatively you can use a laser rangefinder, or calculate an offset from points in the database. This chapter shows you how to calculate offsets using the *Offset* function in the Trimble Survey Controller software.

To do this, choose *Offsets* from the *Survey* menu in a real-time GPS survey or a conventional survey. Measure a topographic (topo) point or a Rapid™ point nearby, then make tape and/or azimuth measurements to the offset point. When you enter these measurements into the Trimble Survey Controller software, it calculates the coordinates of the offset point and stores them in the database.

Remember to include any change in height details, as the height (or elevation) of the offset point is also calculated.



Warning – In general, do not compute offset points and then change the coordinate system or perform a calibration. If you do, these points will be inconsistent with the new coordinate system. An exception to this is offset points computed using the *Brng-dist from a point* method.

Generating Offsets

This section describes how to measure offsets.

To generate an offset point:

1. Measure points near to the offset point.
2. From the main menu, select *Survey / Offsets*.
3. Select an option from the Method field and enter the required information. For more information, see page 186.

4. Tap **Calc** to calculate the solution(s). The Trimble Survey Controller software calculates and displays the coordinates for the offset point. Tap **Store** to store these in the database.

Note – If you use the Four point intersection method or the From a baseline method and then change the antenna height record for one of the source points, the coordinates of the offset point will not be updated.

Options Softkey

Tap **Options** to display the *Options* screen.

Change the *Distances* setting and apply sea level correction if required.

Note – If the measured points were measured using GPS, the coordinates of the offset point can only be displayed as grid values if a projection and a datum transformation are defined.

If you are using a magnetic compass to provide azimuth measurements, specify the magnetic declination.

Azimuths/Angles

If necessary, define a south azimuth and change the incrementation direction of the grid coordinates. For more information, see South Azimuth, and Grid Coordinates, page 64.

Azimuth and angle measurements can be referenced to grid 0°, true north, magnetic north, or the sun. To change this reference, access the *Azimuth origin* field and select the required origin from the list:

- If you are working with magnetic azimuths, enter the local value for magnetic declination. For more information, see Magnetic Declination, page 65.

- If you are working with sun angles, the Trimble Survey Controller software uses GPS time and the current GPS position to calculate the position of the sun (the reference) at the time that the angle is entered.

Choosing a Method (Offsets)

The following sections describe each method for measuring offsets.

Note – You can only use the Bearing-distance from a point method during a postprocessed survey.

From a baseline

Use this method to calculate the coordinates of a point that is offset from a baseline defined by previously measured points. To do this:

1. From the main menu, select *Survey / Offsets*.
2. In the *Method* field, select *From a baseline*.
3. As shown in the following diagram, enter the names of the offset point (8), start point (1), end point (2), right/left offset (3, 4), offset from end (5, 6), and a vertical distance from the end of the line.

Note – Enter a positive offset if the point is offset to the right (3) of the end point, or enter a negative offset if it is to the left (4). Enter a positive offset if the point is outside (5) the end of the line, or enter a negative offset if it is inside (6) the line. Enter 0 for either the left/right offset or in/out offset if you do not want the point offset in that direction.

4. Tap **Calc** to calculate and display the coordinates of the offset point (8). Tap **Store** to store these in the database.

Figure 9.1 shows the screen that appears and a graphical representation of this method.

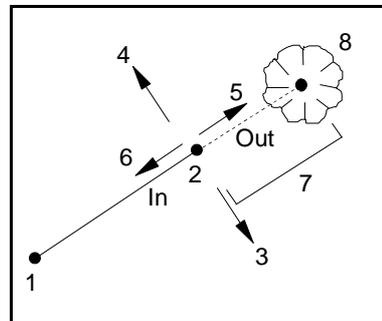
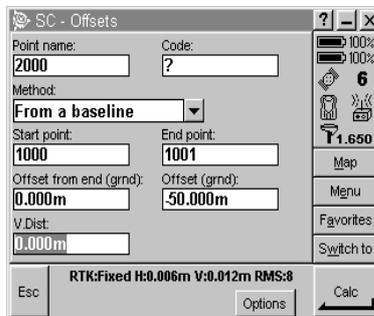


Figure 9.1 From a baseline

Four point intersection

Use this method to calculate the coordinates of an offset point at the intersection of two lines defined by four previously measured points.

To do this:

1. From the main menu, select *Survey / Offsets*.
2. In the *Method* field, select *Four point intersection*.
3. As shown in the following diagram, enter the names of the offset point (5), start point (1) for line 1, end point (2) for line 1, start point (3) for line 2, end point (4) for line 2, and any vertical offset.
4. Tap **Calc** to calculate and display the coordinates of the offset point (5). Tap **Store** to store these in the database.

Figure 9.2 shows the screen that appears and a graphical representation of this method.

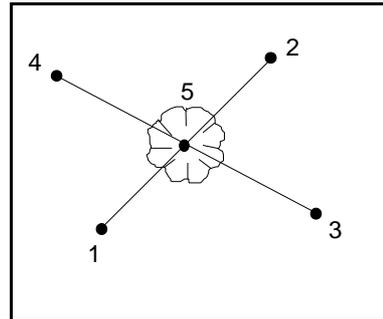


Figure 9.2 Four point intersection

Note – The two lines defined by the previously measured four points do not have to intersect but they do have to converge at some point, as shown in Figure 9.3.

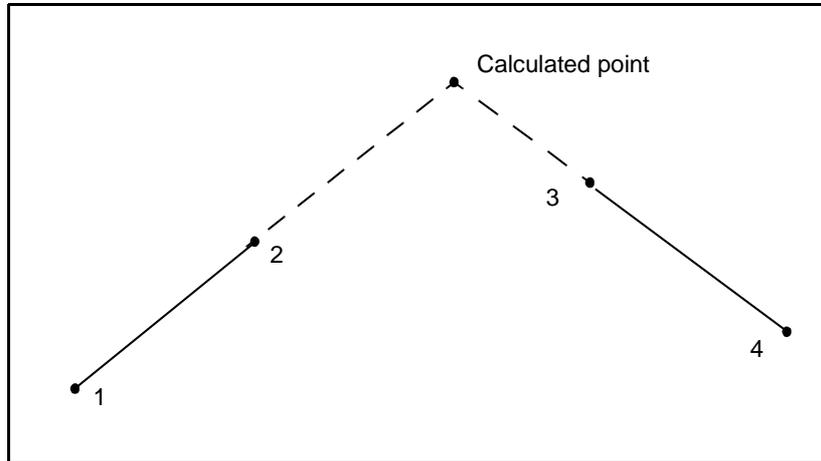


Figure 9.3 Point calculated where lines converge

Bearing–distance from a point

Use this method to calculate the coordinates of an offset point at a certain azimuth and distance from a previously measured point. To do this:

1. From the main menu, select *Survey / Offsets*.
2. In the *Method* field, select *Brng-dist from a point*.
3. As shown in the following diagram, enter the names of the offset point (4), and start point (1), the azimuth origin, the azimuth (2), the horizontal distance (3), and a vertical offset.
4. Tap **Calc** to calculate and display the coordinates of the offset point (4). Tap **Store** to store these in the database.

Figure 9.4 shows the screen that appears and a graphical representation of this method.

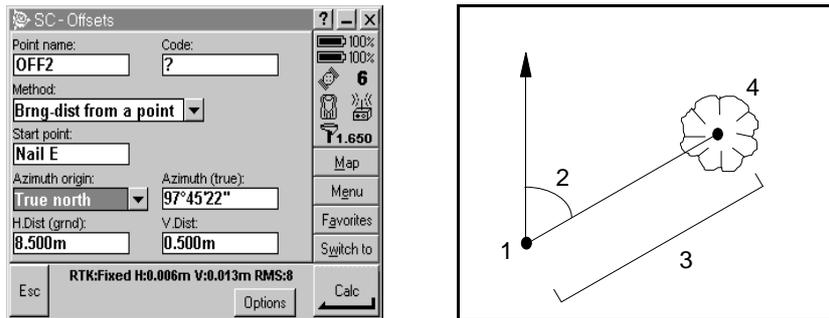


Figure 9.4 Bearing-distance from a point

GPS Survey Styles

In this chapter:

- Introduction
- The concept of Survey Styles
- Using a GPS Survey Style
- Creating and editing a GPS Survey Style
- Differential Survey Styles

Introduction

This chapter tells you how to use GPS survey styles. When you use the Trimble Survey Controller software for a GPS survey, choose from one of nine survey types. These types are based on the kinematic, differential, and FastStatic™ techniques, which are described in this chapter. Select an appropriate survey style for the survey type that you need.

The Concept of Survey Styles

Survey styles make the Trimble Survey Controller software easier to use. Use them to change the configuration of the Trimble Survey Controller software quickly and easily for different types of survey.

In a GPS survey, the survey style instructs the base and rover receivers to perform the functions required for a specific survey type. It also defines the parameters for measuring and storing points. This whole set of information is stored as a template that can be called up and re-used when necessary.

A GPS survey style defines the survey type, antenna information, elevation mask, PDOP mask, and point occupation times. If applicable, it also defines:

- logging intervals
- initialization times
- site calibration defaults
- GPS file storage location
- real-time broadcast message format
- radio communication parameters

Choosing a Survey Style

Trimble provides default GPS survey styles that cover four of the nine possible survey types. To use a survey type not covered by the default survey styles, you must create your own survey style. This is described in *Creating and Editing a GPS Survey Style*, page 198.

Entering the equipment details

The first time that you use a particular survey style to start a survey, the style wizard prompts you to select the type of antenna and the radio (if applicable) that you are using. For more information, see *The Style wizard*, page 197.

Setting the options

Before starting a survey, you can edit many of the options in the survey style that you intend to use. For more information, see *Creating and Editing a GPS Survey Style*, page 198.

Generating a Survey Menu

When you choose the *Survey* icon from the main menu, a list of available survey styles appears. Until you create your own styles, this list contains the four default GPS survey styles and the conventional survey styles. The styles are described in the following sections.

When you select a survey style from the list, the Trimble Survey Controller software generates a menu specific to that style, and displays it on the screen as the *Survey* menu. The options that appear in this *Survey* menu depend on which *type* of survey you chose (by selecting that survey style). For example, a PP Kinematic survey menu never includes *Stakeout* and *Site calibration*, because these items are specific to real-time survey types.

Using a GPS Survey Style

The standard GPS survey styles supplied with the Trimble Survey Controller software system cover the four most popular centimeter-level survey types. The following styles prepare the Trimble Survey Controller software for the appropriate survey:

- **FastStatic** – Use this style for control surveys when no radio is available.

By default, the base receiver is instructed to log raw data at five-second intervals for the duration of the survey.

- **Postprocessed Kinematic (PPK)** – Use this style for topographic or control surveys when no radio is available.

By default, the base receiver is instructed to log raw data at five-second intervals for the duration of the survey.

- **Real-time Kinematic (RTK)** – Use this style for centimeter-level stakeout, as well as topographic and control surveying.

***Note** – Survey styles (such as RTK) that employ the real-time kinematic survey type rely on a trouble-free radio solution.*

By default, the base receiver is instructed to generate real-time kinematic corrections at one-second intervals.

- **Real-time Kinematic & Infill (RTK & Infill)** – Use this style with postprocessed support when base radio corrections are not available.

Use the style for real-time topographic or control surveys if there is a risk of radio link failure. You can also use it if obstructions or interference are a problem, or if the operational range of the radio might be exceeded.

By default, the base receiver is instructed to generate real-time kinematic corrections at one-second intervals and to simultaneously log raw data at five-second intervals for the duration of the base survey.

To configure the survey style, see *Creating and Editing a GPS Survey Style*, page 198.

To conduct a GPS survey using a default survey style:

1. From the main menu, choose the *Survey* icon. Then, from the survey style list, highlight one of the following survey styles:
 - FastStatic
 - PPK
 - RTK
 - RTK & infill

A list appears with survey style options appropriate to the selected survey style.

2. To configure your survey, select these options in turn, and complete each dialog that appears.
3. Start the base receiver. For more information, see Chapter 12, *Starting the Base Receiver*.
4. Start the rover receiver. For more information, see Chapter 13, *Starting the Rover Receiver*.

Options in a Trimble GPS Survey Style

A group of options is associated with each survey type. The selected GPS survey style determines which survey type is used, and which options are available. Once you are familiar with the use of survey styles, you can edit many of the options to further customize individual surveys. For example, you can edit the default setting for the minimum occupation time of a topo point.

Table 10.1 shows the options associated with the default GPS survey styles.

Table 10.1 Options in GPS survey styles

Option	Default GPS survey styles			
	RTK	RTK & infill	PPK	FastStatic
Rover options	✓	✓	✓	✓
Rover radio	✓	✓	–	–
Base options	✓	✓	✓	✓
Base radio	✓	✓	–	–
Laser rangefinder	✓	✓	✓	✓
FastStatic point	–	–	–	✓
Topo point	✓	✓	✓	–
Observed control point	✓	✓	✓	–
Rapid point	✓	✓	–	–
Continuous points	✓	✓	–	–
Stakeout	✓	✓	–	–
Site calibration	✓	✓	–	–
PP initialization times	–	✓	✓	–
Duplicate point actions	✓	✓	✓	✓

Default settings

The default elevation mask for the base receiver and the rover receiver is 13°. The default PDOP mask setting is 6. Other default settings define how point measurements are made.

The Style wizard

The first time that you start a base or rover survey in a GPS survey style, the style wizard prompts you to define the details of the equipment. Select an item, for example, the antenna type, from the displayed list.

The style wizard customizes the chosen survey style, setting any parameters specific to the hardware.



Tip – To correct a mistake when customizing a survey style, first complete the process and then edit the style.

Antenna type

The first time that you start the base or the rover receiver, you must select the type of antenna that you are using from a list.

Table 10.2 shows some common choices.

Table 10.2 Typical antenna configurations

Receiver and station	GPS Total Station receivers		
	5700	4800	4700
Base receiver	Zephyr™ Geodetic	4800 Internal	Micro-centered™ L1/L2 w/GP
Rover receiver	Zephyr	4800 Internal	Micro-centered L1/L2

Radio type

With a real-time system, define the radio solution that you intend to use. The options are: TRIMTALK™ 450, TRIMMARK™, TRIMMARK 3, TRIMCOMM™, Trimble internal, Pacific Crest, Custom radio, and Cellular modem.

Note – With the GPS Total Station 5700, 4800 or 4700 receivers, use an external radio at the base even if you use the internal radio at the rover.



Tip – You can use a Custom radio if the radio you have is not listed.

Creating and Editing a GPS Survey Style

The Trimble Survey Controller software provides survey styles that configure the hardware for four of the nine possible GPS survey types—RTK, RTK & infill, PP Kinematic, and FastStatic.

The other available survey types are:

- RTK & data logging
- RT differential
- RT diff & data logging – This is similar to RTK except that raw GPS data is recorded for the entire survey. This method is useful if you need raw data for quality assurance purposes.

For information about the differential survey styles, see page 215.

To carry out a survey using any of these types, first create a new GPS survey style.

To do this:

1. From the main menu select, *Configuration / Survey Styles*. The *Survey Styles* screen appears. Tap .
2. Enter a name in the *Style name* field and tap .
3. In the *Style type* field, choose GPS. Tap .

The software configures your new survey style as an RTK survey type, and lists the options that are appropriate to this survey style.

If necessary, select *Base options* or *Rover options* from the list and change the survey type. The software updates the list of options so that they are appropriate to the new survey type that you have chosen. (See Table 10.1, page 196.)

Select each menu item in turn. In the screen that appears, set the fields according to your equipment and preferences. For more information about each menu item, see the following sections.

To edit a survey style:

1. End the current survey.
2. From the main menu, select *Configuration / Survey Styles*. The list of survey styles appears.
3. Highlight the name of the survey style to be edited and tap .
4. Change each option as required. For more information about each menu option, see the following sections.

Rover Options and Base Options

There are seven survey types to choose from. Generally, when a GPS Total Station setup consists of one base and one rover receiver, make sure the survey type selected in the *Rover options* field and the *Base options* field is the same. However, when there are multiple rovers, you can have various configurations. Table 10.3 shows the rover survey types that are possible when the base survey type is RTK & infill or PP Kinematic.

Table 10.3 Base support for rover survey types

Base survey type	Possible rover survey types
RTK & infill or RTK & data logging	RTK RTK & infill PP Kinematic FastStatic
PP Kinematic	PP Kinematic FastStatic

The fields that can appear when you select *Rover options* or *Base options* are described below.

Broadcast format

For Real-time Kinematic surveys, the format of the broadcast message can be CMR™, CMR +™, or RTCM RTK 2.x. (CMR is Compact Measurement Record; RTCM is Radio Technical Commission for Maritime Services).

The default is CMR +, which is a format used by the modern Trimble receivers. It is a modified type of CMR record that improves the efficiency of a low bandwidth radio link in real-time surveys. Only use CMR + if all the receivers have the CMR + option installed. To check if this option is installed in the receiver, select *Instrument / Options* on a TSCe data collector that is connected to a receiver.

Note – *If you want to operate several base stations on one frequency, use CMR+. For more information, see Operating Several Base Stations on One Radio Frequency, page 235.*

For wide-area RTK surveys, the broadcast message format can be from the following wide-area RTK solutions: SAPOS FKP, VRS, and CMRNet. For information on using a wide-area RTK system, see Starting a Wide-Area RTK Survey, page 262.

The rover selection should always correspond to the broadcast message format generated by the base.

Output additional code RTCM

For real-time surveys, the base receiver can broadcast the RTK message and the RTCM-104 differential message at the same time. To do this, select the *Output additional code RTCM* check box. (The RTCM output option must be installed in your receiver.)

Note – *When RTCM-104 code and CMR messages are being broadcast, the behavior of rover GPS receivers varies according to type. When you are broadcasting CMR with Output additional code RTCM enabled, only use GPS Total Station 5700 receivers, or GPS Total Station 4700 and 4800 receivers with firmware later than v1.2. Not all receivers will function correctly in this environment because their behavior is receiver- and manufacturer-dependent. Most RTCM-only receivers will work correctly. For more information, contact your local Trimble dealer.*



Warning – Do not use the *Output additional code RTCM* option when using time delays for sharing the radio frequency.

WAAS

When the radio link is down in a real-time survey, the receiver can track and use signals from the Wide Area Augmentation System (WAAS). This provides WAAS positions instead of autonomous GPS positions. To use WAAS positions for more accurate navigation when the radio link is down, set the *WAAS* field to *On*. When using WAAS signals, only Rapid points or postprocessed points can be measured.

Note – For WAAS surveys, you must use a receiver that can track WAAS satellites.

Station index

In real-time surveys, the base receiver broadcasts the station index number as part of the broadcast message. You set the station index number in the *Start base* screen. Set the default station index number for the *Start base* screen in the *Base options / Station index* field of the survey style.

Use station index

If you want to use multiple base stations on one radio frequency, enter the station index number that you want to use first in the *Use station index* field.

If you do not want to use multiple base stations on one frequency, enter the same station index number that you enter in the *Base options* screen.

To use any base station operating on the frequency set in the rover radio, tap .



Warning – If you tap and there are other base stations operating on the frequency, you could use corrections from the wrong base in the rover survey.

For information about using multiple bases, see *Operating Several Base Stations on One Radio Frequency*, page 235.

Prompt for station index

When you use a receiver that supports multiple base stations on one radio frequency, the Trimble Survey Controller software asks you to specify the base to use when you start the rover survey. You can stop this question from appearing by clearing the *Prompt for station index* check box. The station index number in the *Use station index* field is used.

Elevation mask

You must define an elevation mask below which satellites are not considered. For kinematic applications, the default of 13° is ideal for both the base and rover.

For differential surveys where the base and rover are separated by more than 100 kilometers, Trimble recommends that the base elevation mask be lower than the rover setting by 1° per 100 kilometers of separation between the base and rover. Generally, the base elevation mask should be no lower than 10°.

PDOP mask

For the rover option, define a PDOP mask. The Trimble Survey Controller software issues high PDOP warnings when the satellite geometry goes above this threshold. The default value is 6.

Logging device

With survey types that involve postprocessing, set the TSCe data collector to be either the receiver or controller.

To define the logging interval, enter a value in the *Logging interval* field. The base and rover logging intervals must correspond to (or be multiples of) each other.

Antenna type

To set the default antenna height, enter a value in the *Antenna height* field.

To define the antenna details, access the *Type* field and select the correct antenna from the list of antennas. Access the *Measured to* field and select the correct measurement method for the equipment and type of survey. The field that displays the part number is automatically filled. Key in the serial number.

Radios

If you use an RTK survey type to provide real-time positions, you must specify the type of radios used to provide the radio link between the base station and the rover. Specify the type of radio in use at both the base and rover receivers.

For information about configuring a survey style that uses real-time corrections provided by WAAS instead of a radio, see *Differential Survey Styles*, page 214.

To specify the radio used:

1. Select *Rover radio*.
2. In the *Type* field, select your radio from the list.

If your radio does not appear on the list, select *Custom radio* and define the receiver port, the baud rate, and the parity.

If you select *Cellular modem*, see Table 10.4, which shows the Trimble Survey Controller cellular modem commands and information.

Table 10.4 Cellular modem commands and information

Field	Information required	Function of command
Init string (optional)	Command	Starts communication
Hang up	Command	Ends communication

Table 10.4 Cellular modem commands and information

Field	Information required	Function of command
Dial prefix	Command	Dials a number
Number to dial	Phone number of the base station modem Note – Use a comma (,) to send a short delay, for example, to separate the area code from the number.	
Dial suffix (optional)	Command	Software sends to the modem after it has dialled the number.
Note – The <i>Dial prefix</i> , <i>Number to dial</i> , and <i>Dial suffix</i> values are concatenated to send to the modem.		
Post connect (optional)	Information sent from rover to base once connection is confirmed (for example, log-in name and password). Note – Use a carat (^) to send a carriage return and a 3-second delay to the base system, for example, to separate a log-in name from a password.	



Tip – For some cellular modems you must enter a Personal Identification Number (PIN). Usually the command is as follows:

`AT+CPIN="****"` (where **** is the PIN)

If you use a PIN, add the command to the end of the value in the *Init string* field.

3. Select *Base radio*.
4. In the *Type* field, select your radio from the list.

If you select *Cellular modem*, enter the appropriate commands. In the *Init string* field, for the base, the command must leave the modem in auto-answer mode. Alternatively, you can set the auto-answer mode separately.

Ready To Send (RTS) and Clear To Send (CTS)

If you select *Base radio* and set the *Type* field to *Custom radio* or *Cellular modem*, you can also enable *Clear To Send (CTS)*.



Warning – Do not enable CTS unless the receiver is connected to a radio that supports CTS.

The GPS Total Station 5700, 4800, and 4700 receivers support RTS/CTS flow control when you enable CTS. If you are using a GPS Total Station 4700 or 4800 receiver, use receiver firmware version 1.20 or later.

For more information on CTS support, refer to the documentation supplied with your receiver.

Topo Point

Select the *Topo point* survey style option to set the parameters associated with observing topographic points when using the *Measure points* screen.

The *Auto point step size* field defines the increment size for automatic point numbering. The default is 1, but you can use larger step sizes as well as negative steps.

You can store quality control information with each point measurement. The default is *QC1*. For real-time surveys, other options are *QC1 & QC2* and *QC1 & QC3*.

The Trimble Survey Controller software can terminate a topo point measurement and store the result automatically if the *Auto store point* check box is selected. When the number of measurements, the occupation time, and the horizontal and vertical precisions are satisfied, the point is measured and the result is stored.

Observed Control Point

Select the *Observed control point* survey style option for another way to observe points in the field. This option lets you set different observational criteria from those used for topo point measurements.

The Trimble Survey Controller software can terminate observed control point measurements and store the results automatically if the *Auto store point* check box is selected and the occupation times are satisfied. For RTK surveys, the number of measurements and the horizontal and vertical precisions must also be satisfied. The default setting for the *Number of measurements* field is 180. The extended occupation time suggests that this measurement type is ideally suited to points that will be used for control purposes.

Quality control information is automatically stored with each point:

- Real-time observed control points can store QC1, QC1 & QC2, or QC1 & QC3 records.
- Postprocessed observed control points only store QC1 records.

If the *Topo point* option is configured to perform 180 measurements, the positional result is similar to a point measured using the observed control point measurement type. Differences are:

- the default value in the *Quality control* field
- the observation class given by the office software when the point is downloaded

FastStatic Point

You can measure a FastStatic point in a FastStatic survey.

The Trimble Survey Controller software terminates a FastStatic occupation automatically if the *Auto store point* check box is selected and the specified occupation time is satisfied.

The default occupation times are satisfactory for most users. If you change an occupation time, choose a setting according to the number of satellites being tracked by that receiver. Remember that both receivers must track the same satellite at the same time for the data to be useful.



Tip – Use a mobile phone or a walkie-talkie radio to verify that both receivers are tracking the same satellites.

Changing the occupation times directly affects the outcome of a FastStatic survey. Any changes should increase this time rather than decrease it.

Rapid Point

Select the *Rapid point* menu item to configure a Rapid point observation. This is useful for in-field calculations where precision is not vitally important. For example, use the Rapid point observation method to quickly measure the position of the center line on a busy road.

Rapid points are automatically saved if the horizontal and vertical precisions are satisfied. The Trimble Survey Controller software collects just one epoch of data when the preset precisions are reached, so the default precision values should ideally be higher than for other point measurement types. The software uses this single epoch of data to define the point, making Rapid point the least precise measurement method.

You can store quality control information with each Rapid point. The options are QC1, QC1 & QC2, or QC1 & QC3.

Continuous Points

Continuous points use one epoch of data or one real-time measurement to create a point.

In a real-time survey, the Trimble Survey Controller software automatically saves continuous points if the horizontal and vertical precisions are satisfied. In a postprocessed survey, it stores continuous points at the time interval specified in the survey style. Set this interval in the *Logging interval* field of the *Rover options* screen.

Stakeout

To set the as-staked point details:

1. Select the *View before storage* check box to view the differences between the design point and the measured as-staked point before storing the result.

If you select this check box, enter a value in the *Horizontal tolerance* field. The Trimble Survey Controller software displays the deltas if the tolerance is exceeded. The default is 0.000. With the default setting, the deltas are always displayed.

Note – *The Stake delta values are reported as differences from the measured/as-staked point to the design point.*

2. Set the name of the as-staked point to be the next auto point name or a point name that is equivalent to its design name.
3. Set the code of the as-staked point to be the design point name or the design point code.

To set the display:

1. Set the *Display mode* field. The options are:
 - Surveyor centered – the cross that represents your current position stays in the center of the screen and the target moves as you change position.
 - Target centered – the target stays in the center of the screen and the cross moves as you change position.

2. You can enter a value in the *Zoom factor* field. This is the amount that the display zooms in when you switch from Coarse mode to Fine mode while navigating to a point. The default value is 4.0. When you zoom in by this amount, the width of the graphical display corresponds to approximately one meter (or three feet).
3. Set the *Display grid deltas* check box. Do one of the following:
 - Select the check box to display the change in northing and easting during stakeout.
 - Clear the check box to display a bearing and distance.

Note – When you stake out a point, the elevation of the current position is also displayed.

Site Calibration

To set the parameters for computing a calibration, select the *Site calibration* survey style option and do the following:

1. The *Fix H. scale field to 1.0*: check box details whether the calibration computation should compute a horizontal scale factor or not:
 - To compute the horizontal scale factor, make sure the check box is clear. (This is the default setting.) Use this option only if GPS measurements need to be scaled to fit the local control. (GPS measurements are usually more precise.)
 - To fix the horizontal scale factor to 1.0, select the check box. Select the check box to avoid distorting the geometry of the GPS network, but note that the calibration residuals will be higher.
2. Select an observation type appropriate to a calibration point. The options for a calibration point are Topo point or Observed control point.

3. For the Trimble Survey Controller software to automatically perform a calibration when you measure a calibration point, select the *Auto calibrate* check box. To switch automatic calibration off, clear the check box.
4. If necessary, set the tolerances for maximum horizontal and vertical residuals, and maximum and minimum horizontal scale settings. These settings only apply to automatic calibration and do not affect manual calibration.

You can also specify the maximum slope of the vertical adjustment plane. The Trimble Survey Controller software warns you if the slope in the north direction or the slope in the east direction exceeds this. Generally the default settings are appropriate.

5. Specify how the calibration points you measure will be named:
 - a. In the *Method* field, choose one of the following options: *Add prefix*, *Add suffix*, or *Add constant*.
 - b. In the *Add* field, enter the prefix, suffix, or constant.

Table 10.5 shows the different options and gives an example of each.

Table 10.5 Calibration point name options

Option	What the software does	Example value in the Add field	Grid point name	Calibration point name
Same	Gives the calibration point the same name as the grid point	—	100	100
Add prefix	Inserts a prefix before the grid point name	GPS_	100	GPS_100
Add suffix	Inserts a suffix after the grid point name	_GPS	100	100_GPS
Add constant	Adds a value to the grid point name	10	100	110

PP Initialization Times

Select the *PP initialization times* survey style option to define initialization times. Generally the default settings are appropriate.



Warning – Reducing any of these times can affect the outcome of a postprocessed survey. Increase these times rather than decrease them.

Duplicate Point Actions

When you enter the name of a new point, the Trimble Survey Controller software warns if a point of the same name already exists.

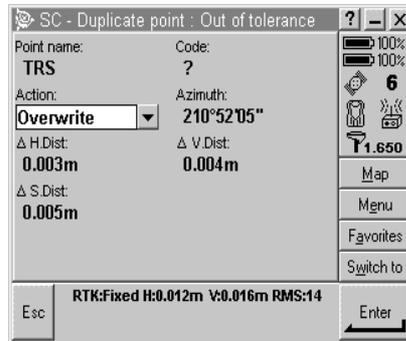
In a real-time GPS survey, set the tolerances for a duplicate point warning—specify the maximum distance that the new point can be from the existing point. A duplicate point warning appears when you try to store the new point, but only if it is outside the tolerance set. This warning also appears when you key in a duplicate point. If a survey is not running, the tolerances in the last real-time survey are used to perform the check.

Specify horizontal and vertical tolerances in the *Duplicate point actions* screen. The default is 0.000. With the default setting, a warning is always given. To disable the warning, enter high values in the *Horizontal* and *Vertical* fields. The range for these settings is 0.000 m to 1000.000 m.

Duplicate point: Out of tolerance screen

If the new point is “within tolerance” (that is, it has the same name as an existing point and is closer to the existing point than the tolerance specified), the new point is stored.

However, if the new point is “out of tolerance” (that is, it is further from the original point than the tolerance specified), the following screen appears:



In the *Action* field, choose what to do with the new point, from the following options:

- Discard
- Rename
- Overwrite – Overwrite and delete the original point, and all other points of the same name and the same (or lower) search class.
- Store as check – Store with a lower classification.
- Store another – Store the point, which can then be averaged in the office software. The original point is used in preference to this point.
- Store and reorient – Store the point, which is then used as the backsight observation for subsequent measurements.

Similarly, if you enter a duplicate point name, you must choose what to do with the duplicate point.

For information about point classification, and how the Trimble Survey Controller software uses search classes, see Database Search Rules, page 423.

Differential Survey Styles

This section describes the differential survey styles that you can use with the Trimble Survey Controller software, and shows how to create a differential survey style.

Differential Survey Types

Differential GPS surveys can be real-time, postprocessed, or a combination of both. For real-time differential surveys, the GPS receiver can track and process signals from the Wide Area Augmentation System (WAAS) instead of using a ground-based RTCM broadcast message. You do not need to use a radio.

Note – For WAAS surveys, you must use a receiver that can track WAAS satellites.

When using WAAS signals, only Rapid points or postprocessed points can be measured.

To conduct a differential survey, first create a survey style that uses a differential survey type. (For more information, see *Creating a Differential Survey Style*, page 215.) The two differential survey types are described in the following sections:

- **RT differential** – This survey uses the RTCM broadcast message and relies on a reliable radio for the duration of the survey. Alternatively, use WAAS signals to provide real-time positions instead of a radio.
- **RT diff & data logging** – This survey works in the same way as an RT differential survey, except that data is recorded for the entire survey both at the base and at the rover receivers. This method is useful if raw data is required for quality assurance purposes.

Creating a Differential Survey Style

To create a differential survey style:

1. From the main menu select *Configuration / Survey Styles*.
2. Tap .
3. Enter a name in the *Style name* field and tap .
4. In the *Style type* field, choose *GPS* and tap .
5. Choose *Rover options* or *Base options* and make the appropriate changes to the *Type* field. In this case, change it to the differential method that you want to use. The survey type you select depends on whether the technique you choose is real-time or postprocessed.
6. For both real-time and postprocessed techniques, define an elevation mask and antenna for the base and the rover. For the rover options, define Broadcast format, the PDOP mask, and the RTCM age limit. In a differential survey you can choose to set the *Broadcast format* field to RTCM or WAAS.
7. For methods that involve data logging, specify whether the data is to be logged in the receiver or in the Trimble Survey Controller software, and define the interval.

For real-time techniques, the RTCM-SC104 version 2 broadcast message format is used. Real-time signals are generated at 1-second intervals.

For more information about options in a survey style, see *Creating and Editing a GPS Survey Style*, page 198.

Field Techniques for Differential Surveying

Differential surveys require four satellites that are common to the base and the rover receivers. Differential surveys do not require initialization.

The success of a real-time differential survey, like that of an RTK survey, depends on the radio solution that you are using. Assuming a trouble-free radio solution, two fixes per second are possible.

***Note** – For postprocessed surveys, always collect enough data at each station.*

Antennas

In this chapter:

- Introduction
- Measuring antenna heights
- Antenna.ini file

Introduction

This chapter describes the antennas that can be used during a GPS survey.

Measuring Antenna Heights

The antenna receives GPS signals at the antenna phase center (APC). The APC is inside the plastic housing, so it is not possible to measure directly to it. Instead, measure the height from the survey mark on the ground to a specified part of the antenna housing. Enter the antenna height, then, in the *Measured to* field, specify the part on the housing where the measurement was taken.

For example, with a Zephyr or Micro-centered™ antenna, measure to the bottom of the plastic antenna housing. Enter this value in the *Antenna height* field and, in the *Measured to* field select Bottom of antenna. With a GPS Total Station 4800 antenna, enter 1.800 m in the *Antenna height* field.

The Trimble Survey Controller software corrects the antenna height value according to the antenna type selected and the setting in the *Measured to* field. It calculates the APC based on the antenna type, the uncorrected height, and the value in the *Measured to* field. This APC height is used to calculate the ground height for points.

Measuring the Height of an Antenna on a Range Pole

Figure 11.1 shows how to measure the height of an antenna mounted on a range pole when the *Measured to* field is set to *Bottom of antenna* or *Bottom of antenna mount*. With a fixed height range pole, the height is a constant value.

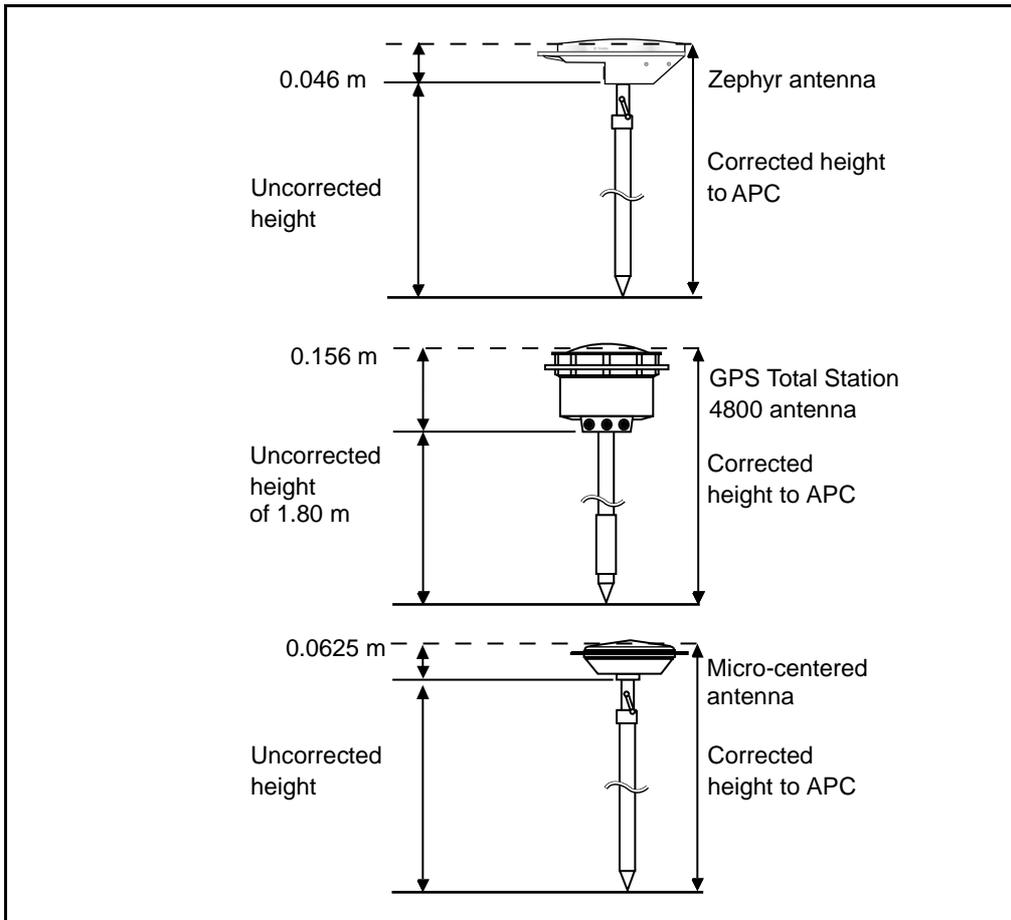


Figure 11.1 Measuring the height of a receiver mounted on a range pole

Measuring the Height of an Antenna on a Tripod

The way to measure this depends on the equipment used.

Zephyr antenna

If this antenna is mounted on a tripod, measure the height to the top of the notch on the side of the antenna. See Figure 11.2.

Zephyr Geodetic antenna

If this antenna is mounted on a tripod, measure the height to the bottom of the notch on the side of the antenna. See Figure 11.2.

GPS Total Station 4800 receiver

If this antenna is mounted on a tripod, measure the uncorrected height to one of the eight protruding notches on the edge of the plastic antenna housing. These are located inside the external shock resistant housing ring. Use the special measuring tape provided by Trimble. Enter a value in the *Antenna height* field, and, in the *Measured to* field, select *Hook using 4800 tape*.



Tip – If you are using a fixed height tripod, you can measure the height to the bottom of the antenna housing and select *Bottom of antenna mount* in the *Measured to* field.

Micro-centered L1/L2 antenna

If this antenna is mounted on a tripod, measure the height to the bottom of the plastic housing. Enter this value in the *Antenna height* field and set the *Measured to* field to *Bottom of antenna*.

Ground plane

If you are using a ground plane, see the next section.

Measuring the Height of an Antenna When Using a Ground Plane

A ground plane reduces the incidence of multipath. For more information, see *Multipath*, page 265. It is generally used only at a base receiver.

If you are using a ground plane, choose the *w G/P* option in the *Antenna type* field (for example, *Compact L1/L2 w G/P*).

Figure 11.2 shows how to measure the uncorrected height of a Micro-centered antenna (or a Compact L1/L2 antenna) that has a ground plane. Measure to the underside of the notch in the ground plane.

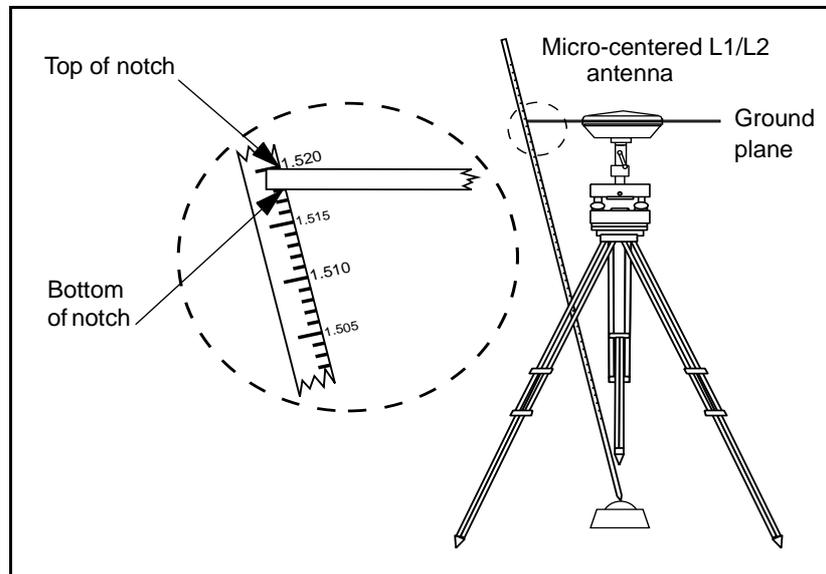


Figure 11.2 Measuring the height of the antenna when using a ground plane



Tip – Measure the height to three different notches around the perimeter of the ground plane. Then record the average as the uncorrected antenna height.

Antenna.ini File

The Trimble Survey Controller software includes an integrated Antenna.ini file that contains a list of antennas that you can choose from when creating a survey style. You cannot edit this list in the Trimble Survey Controller software. However, if you want to shorten the list or add a new antenna type, you can edit and transfer a new Antenna.ini file.

To edit the antenna.ini file, use a text editor such as Microsoft Notepad. Edit the *Survey Controller* group, and transfer the new Antenna.ini file to the Trimble Survey Controller software, using Trimble's Data Transfer utility.

Note – When you transfer an Antenna.ini file, it overwrites any existing file of that name. The information in this file is also used in preference to the antenna information built into the Trimble Survey Controller software.

Starting the Base Receiver

In this chapter:

- Introduction
- Base station coordinates
- Setting up the equipment for a real-time survey
- Setting up the equipment for a postprocessed survey
- Setting up the equipment for a real-time and postprocessed survey
- Starting a base survey
- Ending a base survey

Introduction

This chapter describes how to start the base receiver for a GPS survey.

Base Station Coordinates

When you set up a base, it is important to know the WGS-84 coordinates of the point as accurately as possible.

Note – Every 10 m of error in a base station coordinate can introduce up to 1 ppm scale error on every measured baseline.

The following recognized methods, listed in descending order of accuracy, are used to determine base station WGS-84 coordinates:

- Published or precisely-determined coordinates.
- Coordinates computed from published or precisely-determined grid coordinates.
- Coordinates derived using a reliable differential (RTCM) broadcast based on published or precisely-determined coordinates.
- A WAAS position generated by the receiver—use this method if no control exists for the location and you have a receiver that tracks WAAS satellites.
- An autonomous position generated by the receiver—use this method for real-time surveys in a location where no control exists. Trimble strongly recommends that you calibrate any jobs started by this method on a minimum of four local control points.



Tip – In the U.S.A., you can regard NAD83 geodetic coordinates as equivalent to WGS-84 coordinates.

Note – If the keyed in WGS-84 coordinates differ from the current autonomous position generated by the receiver by more than 500 m, a warning message appears.

For more information about entering base station coordinates, see Starting a Base Survey, page 242.

Survey Integrity

To preserve the integrity of a GPS survey, consider the following:

- When you start subsequent base receivers for a particular job, make sure that each new base coordinate is in the same terms as the initial base coordinate.

*Note – Within a job, only use an autonomous position to start the **first** base receiver. An autonomous position is equivalent to an assumed coordinate in conventional surveying.*

- Coordinates published by a reliable source and coordinates determined by control surveys should be in the same system.
- If subsequent base coordinates are not in the same terms, regard observations from each base as a separate job. Each needs a separate calibration.
- Because measured real-time kinematic points are stored as vectors from the base station, not as absolute positions, the origin of the survey must be an absolute WGS-84 position from which the vectors radiate.

If other base stations are subsequently set up on points measured from the original base station, all vectors are resolved back to the original base station.

- It is possible to start the base on any kind of coordinates, for example, grid or local ellipsoid coordinates. However, in a real-time survey, the Trimble Survey Controller software must store a WGS-84 position for the base when a rover survey is started. It is this position that is held fixed as the origin of the network.

When you start a rover survey, the Trimble Survey Controller software compares the WGS-84 position broadcast by the base receiver with points already in the database. If a broadcast point has the same name as a point in the database, but different coordinates, the Trimble Survey Controller software uses the coordinates that are in the database. These coordinates were keyed in or transferred by you, so it assumes that you want to use them.

If a point in the database has the same name as the one being broadcast by the base, but the coordinates are NEE or local LLH rather than WGS-84 coordinates, the Trimble Survey Controller software converts this point to WGS-84 coordinates using the current datum transformation and projection. It then uses these as the base coordinates. If no datum transformation and projection are defined, the broadcast WGS-84 point is automatically stored and used as the base.

Figure 12.1 shows a survey using two base stations.

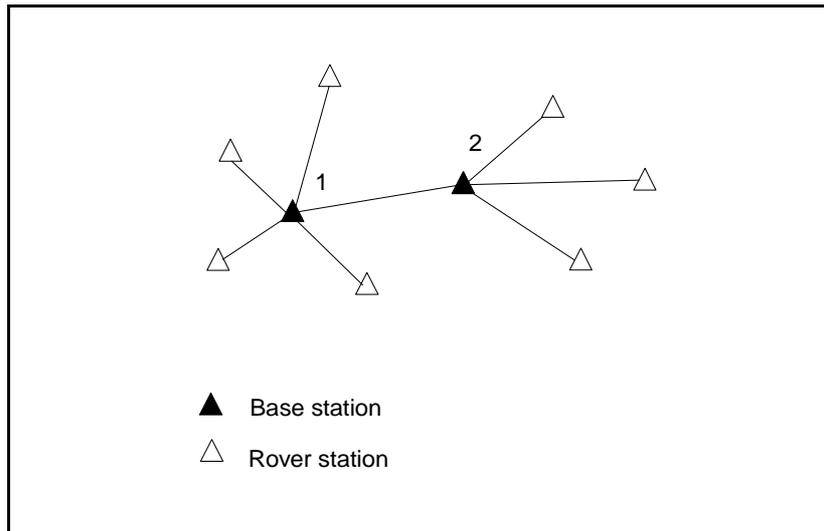


Figure 12.1 Using more than one base station in a survey

In this survey, Base station 2 was first surveyed as a roving point from Base station 1.

*Note – Base stations 1 and 2 **must** be linked together by a measured baseline, and Base station 2 **must** be started with the same name that it had when it was surveyed as a roving point from Base station 1.*

Setting up the Equipment for a Real-Time Survey

This section describes how to assemble the hardware components at the base receiver for a Real-time kinematic (RTK) or Real-time differential (RT differential) survey. Follow these steps if you are using a GPS Total Station 5700, 4800, or 4700 receiver.

Using a GPS Total Station 5700 Receiver

To set up a base receiver for a real-time survey using a Trimble 5700 receiver:

1. Set the Zephyr antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Use the tripod clip (part number 43961) to hang the 5700 receiver on the tripod.
3. Connect the Zephyr antenna to the yellow GPS receiver port labeled “GPS”. Use the yellow GPS antenna cable (part number 41300-10).

Note – Instead of hanging the receiver on the tripod, you can place the receiver in its base case. Run the antenna cable out of the portal in the side of the base case to the antenna so that the case can stay closed while the receiver is running.

4. Assemble and erect the radio antenna.
5. Connect the radio antenna to the radio using the cable attached to the antenna.

6. Connect the radio to the GPS receiver port 3.
 - If using a Trimble radio, use the supplied cable.
 - If using a radio provided by a third party, use the appropriate cable.

Note – For some third-party radios, a separate power supply is needed for the radio.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

7. If external power is required, connect the power supply with a 0-shell Lemo connection to port 2 or port 3 on the receiver.
8. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
9. Turn on the TSCe data collector, then follow the instructions in Starting a Base Survey, page 242.

Figure 12.2 shows how to set up the base receiver for a real-time survey using a GPS Total Station 5700 receiver.

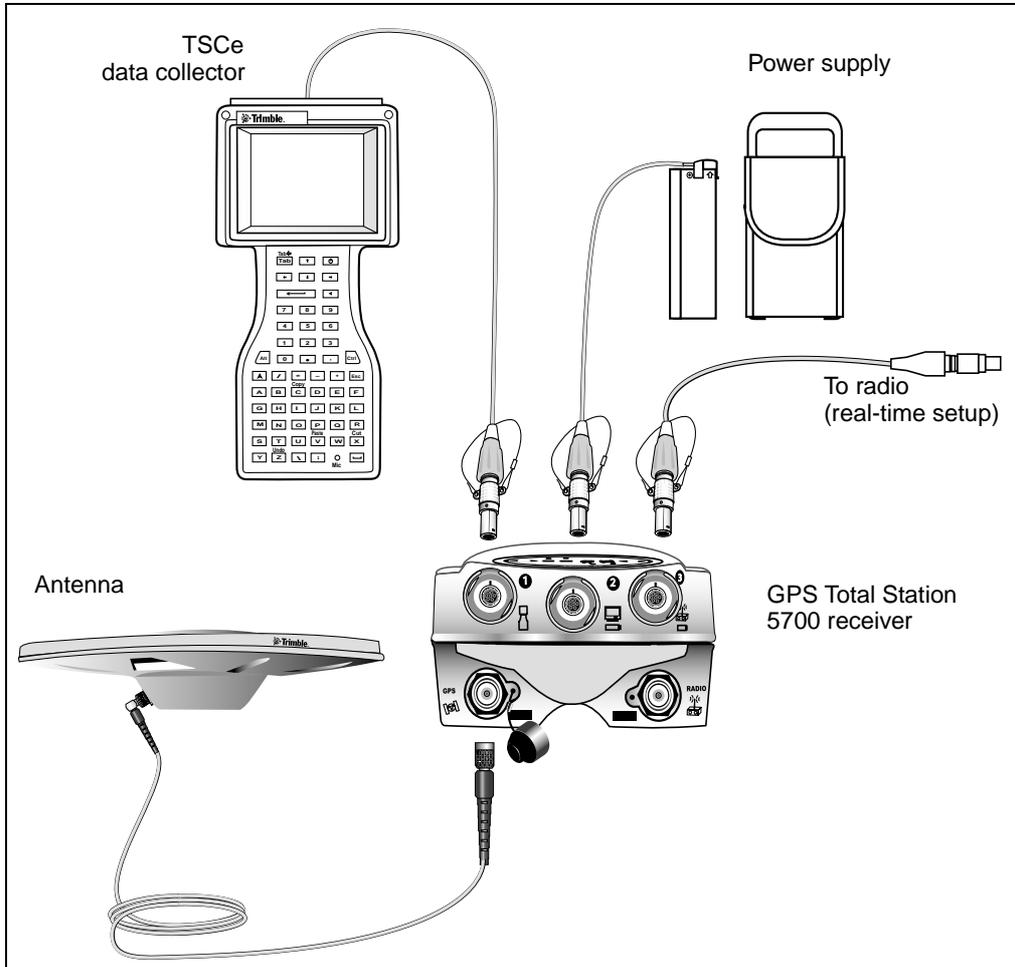


Figure 12.2 GPS Total Station 5700 system

Using a GPS Total Station 4800 Receiver

To assemble the base receiver hardware for a real-time survey using a GPS Total Station 4800 receiver, see Figure 12.3. Then do the following:

1. Set the GPS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Assemble and erect the radio antenna.
3. Connect the radio antenna to the radio using the cable attached to the antenna.
4. Use the supplied cable to connect the radio to the GPS receiver port 3.

Note – With slightly older equipment, you may have to use an adaptor cable (part number 34383) with the base station radio cable when connecting the base station radio to the GPS receiver.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

5. Connect the power supply to the GPS receiver port 2 and turn on the receiver.
6. Connect the TSCe data collector to the GPS receiver port 1.
7. Turn on the TSCe data collector, then follow the instructions in Starting a Base Survey, page 242.

Figure 12.3 shows how to set up the base receiver for a real-time survey using a GPS Total Station 4800 receiver.

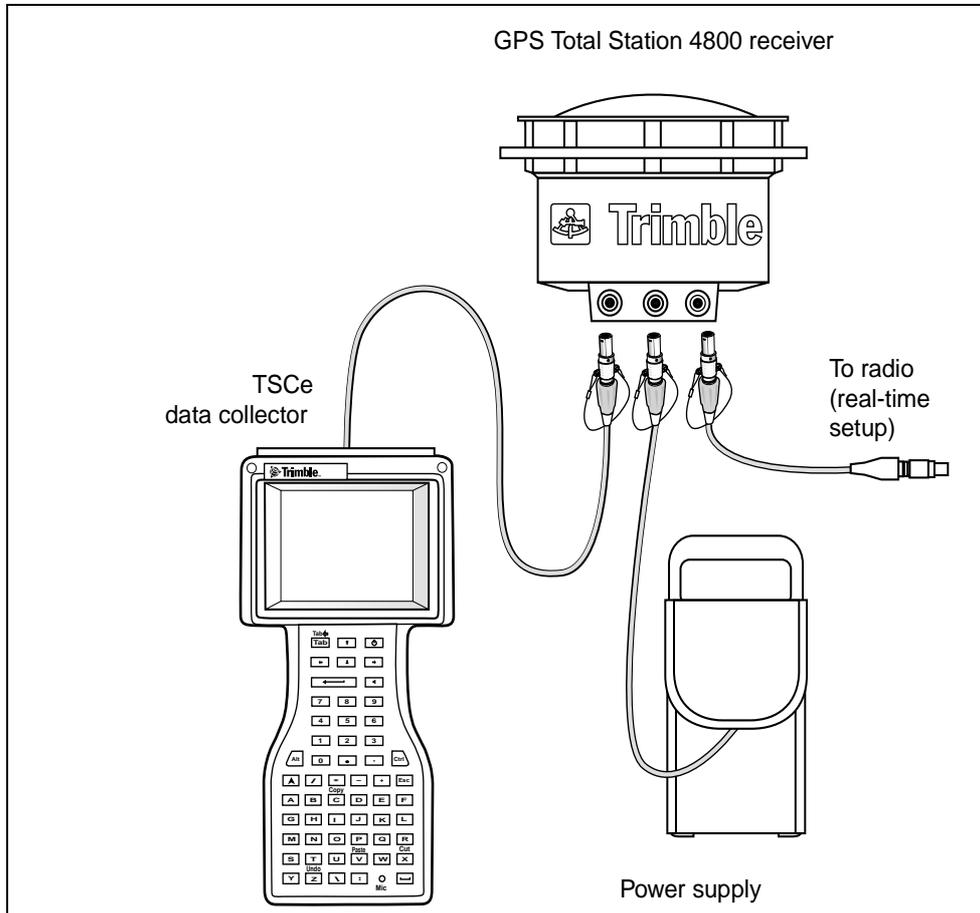


Figure 12.3 GPS Total Station 4800 system (external radio)

Using a GPS Total Station 4700 Receiver

To set up a base receiver for a real-time survey using a GPS Total Station 4700 receiver, see Figure 12.4. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. For more information, see *Measuring the Height of an Antenna When Using a Ground Plane*, page 221.
2. Connect the GPS antenna to the GPS receiver port labeled “GPS ANTENNA”. Use the N-type to Lemo co-axial cable.
3. Assemble and erect the radio antenna.
4. Connect the radio antenna to the radio using the cable attached to the antenna.
5. Connect the radio to the GPS receiver port 3.
 - If using a Trimble radio, use the supplied cable.
 - If using a radio provided by a third party, use the appropriate cable.

Note – For some third-party radios, a separate power supply is needed for the radio.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

6. Connect the power supply to the GPS receiver port 2 and turn on the receiver.
7. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
8. Turn on the TSCe data collector, then follow the instructions in *Starting a Base Survey*, page 242.

Figure 12.4 shows how to set up the base receiver for a real-time survey using a GPS Total Station 4700 receiver.

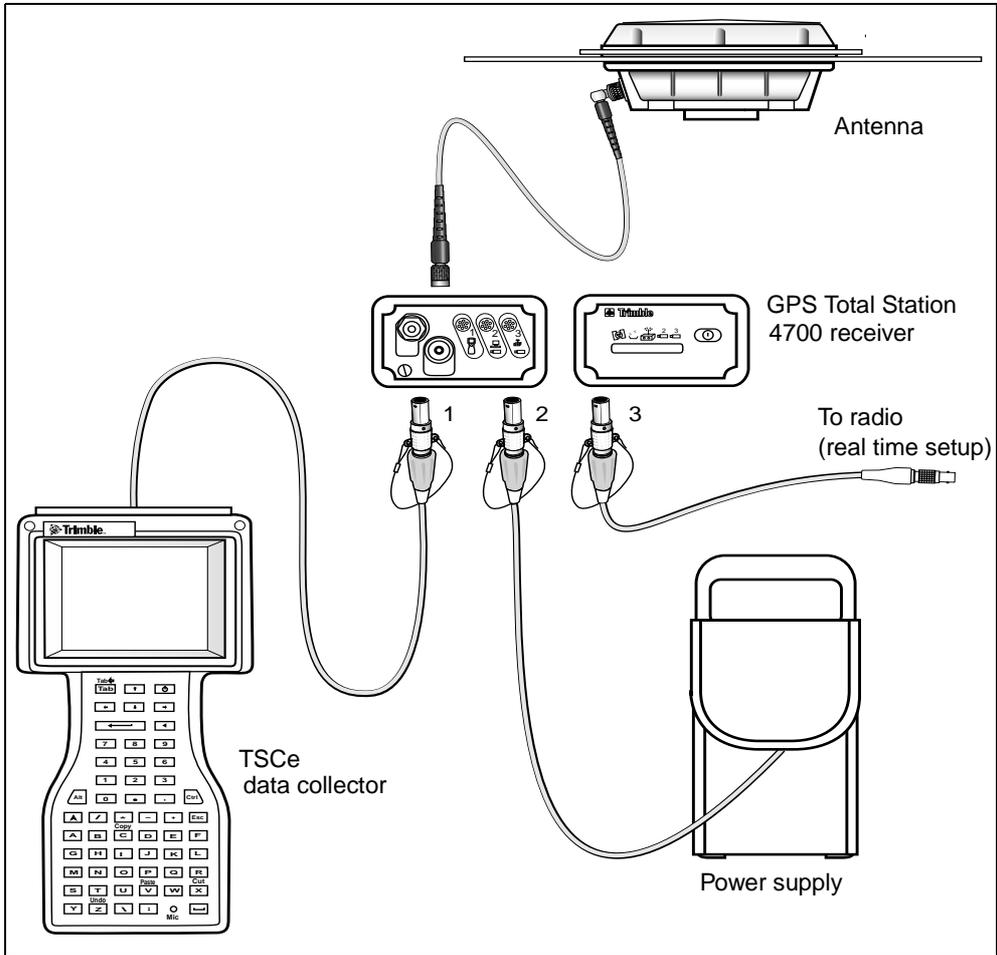


Figure 12.4 GPS Total Station 4700 receiver (external radio)

Radio Solutions

Trimble provides a comprehensive range of radio solutions that have been tested and proven. TRIMTALK radios are powered by the receiver's power supply using a common data/power cable. This configuration simplifies battery issues, as the receiver and the radio use the same power source. The GPS Total Station 5700, 4800 and 4700 receivers can use a TRIMMARK III, TRIMMARK IIe or a TRIMTALK 450S radio at the base, and an internal radio at the rover.

Cellular modems can be used at both the base and rover receivers. For information about setting up cellular modems in the survey style, see Radios, page 204.

Note – Cellular modems used with the Trimble Survey Controller software must support Hayes compatible AT commands.

Base receivers used with modems must support CTS flow control.

You can use the Trimble Survey Controller software to configure the radios. For more information, see Configuring a radio using the Trimble Survey Controller software, page 238.

Radio considerations

Real-time survey methods rely on trouble-free radio transmission.

Note – The precision of measured points is not affected by radio performance.

To reduce the effects of interference from other base stations operating on the same frequency, use a transmission delay for your base station that does not coincide with others on the same frequency. For more information, see Operating Several Base Stations on One Radio Frequency, page 235.

Sometimes the conditions or topography of a site adversely affect radio transmission, resulting in limited coverage.

To increase site coverage:

- Move the base stations to prominent points around the site.
- Erect the base radio antenna as high as possible.
- Use radio repeaters.



Tip – Double the height of the broadcast antenna to increase the coverage by approximately 40%. To achieve the same effect, it would be necessary to quadruple the radio broadcast power.

Operating Several Base Stations on One Radio Frequency

In an RTK survey you can reduce the effects of radio interference from other base stations on the same frequency by operating your base station with a different transmission delay. This allows you to operate several base stations on one frequency. The general procedure is as follows:

1. Check that you have the correct hardware and firmware.
2. Set up the equipment and start a survey at each base station, specifying a transmission delay and a station index number.
3. Start a rover survey and specify which base to use.

Hardware and firmware requirements

To operate several base stations on one frequency, you must use receivers that support the CMR Plus correction record format.

All other base and rover receivers must be GPS Total Station 5700 receivers, or 4700 and 4800 receivers with firmware version 1.20 or later.

Note – *Do not use transmission delays if you intend to use radio repeaters.*

Starting the base with a transmission delay

When you use multiple base stations, you set the transmission delay for each base when you start the base survey. Each base must broadcast with a different transmission delay and station index number. The delays allow the rover to receive corrections from all of the base stations at once. The station index numbers let you select which base station to use at the rover.

Note – You can only set the base radio transmission delay when using a GPS Total Station 5700 receiver, or a GPS Total Station 4700 or 4800 receiver with firmware version 1.20 or later.

When you carry out surveys using different base stations in one job, make sure that the coordinates of the base stations are in the same coordinate system and are in terms of each other.

Before you start the base receiver, do the following:

1. Select the CMR Plus correction message format. Select this in the survey style for both the base and the rover.
2. Set the over air baud rate in the radio to at least 4800 baud.

Note – If you use a 4800 over air baud rate you can only use two base stations on one frequency. Increase the over air baud rate if you want to increase the number of base stations on one frequency.

When you start the base survey, do the following:

1. In the *Station index* field, enter a value within the range 0-29. This number is broadcast in the correction message.



Tip – You can configure the default station index number in the survey style. For more information, see *Station index*, page 202.

2. If the receiver you are using supports transmission delays, the *Transmission delay* field appears. Choose a value, depending on how many base stations you want to use. See Table 12-1.

Table 12-1 Number of bases/transmission delays

No. of base stations	Use these delays (in ms) ...			
	Base 1	Base 2	Base 3	Base 4
One	0			
Two	0	500		
Three	0	350	700	
Four	0	250	500	750

For more information about starting the base survey, see Starting a Base Survey, page 242.

For information about starting the rover and selecting which station index to use, see Starting a Rover Survey, page 257.

Radio Repeaters

Radio repeaters increase the broadcast range of a base radio by receiving the base transmission and then rebroadcasting it on the same frequency.

Trimble provides five radio solutions for use with the Trimble Survey Controller system.

You can use one repeater with the TRIMTALK 450S (12.5 kHz) radio, and one or two repeaters with the TRIMTALK 450S (25 kHz) radio. For details of the TRIMMARK 3, TRIMMARK II / IIe, TRIMCOMM, and Pacific Crest radios, please refer to the specific product documentation.

Note – To use any of these radios as repeaters, they must be configured as repeaters. For instructions on how to do this, see the next section.

Configuring a radio using the Trimble Survey Controller software

Use the Trimble Survey Controller software to:

- change the frequency of a radio.
- change the mode of a radio from a broadcasting/receiving radio to a repeater radio.
- change the wireless data rate.

Note – You can only change the frequency when configuring a Pacific Crest radio.

To configure a radio:

1. Connect the TSCe data collector, receiver, power, and radio. For more information, see Figure 12.2 on page 229, Figure 12-3 on page 231, or Figure 12-4 on page 233 (depending on the equipment).

Alternatively, use a Y-cable to connect the power and the TSCe data collector directly to the radio.

2. On the TSCe data collector, highlight your survey style and tap  .
3. Select *Base radio* or *Rover radio* depending on which radio you are configuring.
4. Set the *Type* field and, if connecting directly, the *Controller port* field.

If connecting through a receiver, set the *Receiver port* field.

5. Tap  .

Note – If the softkey is not displayed, you cannot configure the type of radio you have selected.

If you are configuring a radio other than the internal radio of a GPS Total Station 5700, 4800, or 4700 receiver, the following message appears:

Please confirm. Disconnect power from radio.

6. Disconnect the power from the radio and tap .
The following message appears:
Please confirm. Connect power to radio.
7. Reconnect the power to the radio and tap . (There is no need to tap for a Pacific Crest radio.)
The second *Base radio/Rover radio* screen appears.
8. Change the settings in the *Frequency* field and the *Base radio mode* field, as required.
The radio firmware version is also displayed.
9. Tap when the details are correct. (There is no need to tap for a Pacific Crest radio.)

Note – In some countries it is illegal to change the frequency of a radio. The Trimble Survey Controller software uses the latest GPS position to see if you are in one of these countries. If you are, only the available frequencies are displayed in the Frequency field.

Setting Up the Equipment for a Postprocessed Survey

This section shows how to assemble the hardware components at the base receiver for a postprocessed kinematic, a postprocessed differential or a FastStatic survey. Follow these steps when using a GPS Total Station 5700, 4800, or 4700 receiver.

Using a GPS Total Station 5700 Receiver

To set up the base receiver for a postprocessed survey using a GPS Total Station 5700 receiver, see Figure 12.2. Then do the following:

1. Set the Zephyr antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Use the tripod clip (Part Number 43961) to hang the 5700 receiver on the tripod.
3. Connect the Zephyr antenna to the yellow GPS receiver port labeled GPS. Use the yellow GPS antenna cable (part number 41300-10).

Note – Instead of hanging the receiver on the tripod, you can place the receiver in its base case. Run the antenna cable out of the portal in the side of the base case to the antenna so that the case can stay closed while the receiver is running.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

4. If external power is required, connect the power supply with a 0-shell Lemo connection to Port 2 or Port 3 on the receiver.
5. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
6. Turn on the TSCe data collector, then follow the instructions in Starting a Base Survey, page 242.

Using a GPS Total Station 4800 Receiver

To set up the base receiver hardware for a postprocessed survey using a GPS Total Station 4800 receiver, see Figure 12.3. Then do the following:

1. Set the GPS receiver over the ground mark using a tripod, a tribrach, and a tribrach adaptor.
2. Connect the power supply to the GPS receiver port 2 and turn on the receiver.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the TSCe data collector to the GPS receiver port 1.
4. Turn on the TSCe data collector, then follow the instructions in Starting a Base Survey, page 242.

Using a GPS Total Station 4700 Receiver

To set up a base receiver for a postprocessed survey using a Trimble GPS Total Station 4700 receiver, see Figure 12.4. Then do the following:

1. Set the GPS antenna over the ground mark using a tripod, a tribrach, and a tribrach adaptor. If one of the GPS antennas has a ground plane, use this as the base antenna. For more information, see Measuring the Height of an Antenna When Using a Ground Plane, page 221.
2. Connect the GPS antenna to the GPS receiver port labeled “GPS ANTENNA”. Use the N-type to Lemo co-axial cable.



Warning – Do not force plugs into the receiver ports. Check the number of pins in the plug to make sure that the socket is compatible. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the power supply to the GPS receiver port 2 and turn on the receiver.
4. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
5. Turn on the TSCe data collector, then follow the instructions in Starting a Base Survey, page 242.

Setting Up the Equipment for a Real-Time and Postprocessed Survey

To conduct a survey that uses both real-time and postprocessed techniques, follow the assembly instructions for real-time surveys. If the receiver has no memory (or has a limited memory), use a TSCe data collector to store raw data at the base receiver.

Starting a Base Survey

To conduct a survey using a predefined survey style, make sure that the required job is open. The title of the main menu should be the current job name.

From the main menu, choose *Survey* and select a survey style from the list. To create or edit a survey style, see *Creating and Editing a GPS Survey Style*, page 198.

A *Survey* menu is generated. It displays items specific to the chosen survey style and includes the *Start base receiver* and *Start survey* items.



Warning – In a real-time survey, make sure that the radio antenna is connected to the radio before starting the base survey. If it is not, the radio will be damaged.

To start a base survey:

1. From the *Survey* menu, choose *Start base receiver*.
 - If the TSCe data collector is connected to a receiver that was logging data, the data logging is stopped.
 - The first time that you use this survey style, the Style wizard prompts you to specify the equipment you are using. For more information, see *The Style wizard*, page 197.

The *Start base* screen appears.

Note – When you start a survey, the Trimble Survey Controller software automatically negotiates the highest possible baud rate for communicating with the connected receiver.

2. Enter the base station name and coordinates. For more information, see Base Station Coordinates, page 224. Use one of the following methods.:
 - If WGS-84 coordinates are known:

Access the *Point name* field and enter the point name. Tap .

In the *Key in point* screen, set the *Method* field to *Keyed in coordinates*. Check that the coordinate fields are *Latitude*, *Longitude*, and *Height (WGS-84)*. If they are not, tap and change the *Coordinate view* setting to *WGS-84*. Key in the known WGS-84 coordinates for the base station, and tap .
 - If grid coordinates are known, and projection and datum transformation parameters are defined:

Access the *Point name* field and enter the point name. Tap .

In the *Key in point* screen, set the *Method* field to *Keyed in coordinates*. Check that the coordinate fields are *Northing*, *Easting*, *Elevation*. If they are not, tap and change the *Coordinate view* setting to *Grid*. Key in the known grid coordinates for the base station, then tap .
 - If local geodetic coordinates are known and a datum transformation is defined:

Access the *Point name* field and enter the point name. Tap .

In the *Key in point* screen, set the *Method* field to *Keyed in coordinates*. Check that the coordinate fields are *Latitude*, *Longitude*, and *Height (Local)*. If not, press and change the *Coordinate view* setting to *Local*. Key in the known local coordinates for the base station, then tap .

In a real-time survey, select either the current WAAS position, or the current autonomous position, derived by the GPS receiver.

Then, access the *Point name* field and enter the point name. Tap to access the *Key in point* screen. Tap and the current position is displayed. Tap to accept and store this position.

Note – If you want a WAAS position, ensure the receiver is tracking a WAAS satellite by checking the WAAS icon is displayed on the status line when you tap . The receiver can take 120 seconds to lock on to WAAS. Alternatively, check the *Observation class* field before starting the base.



Warning – Within a job, only use an autonomous position (the softkey) to start the first base receiver.

Note – If you carry out a real-time survey using RTCM corrections and use a base point name that is more than eight characters long, the name will be shortened to eight characters when it is broadcast.

3. The *Observation class* field shows the observation class of the base point. For more information, see *Observation class*, page 303.
4. Enter values in the *Code* (optional) and *Antenna height* fields.
5. Set the *Measured to* field as appropriate.
6. In the *Station index* field, enter a value.

This value is broadcast in the correction message, and must be in the range 0-29.



Tip – Tap **Scan** to view a list of other base stations operating on the frequency you are using. The list shows the station index numbers of the other bases and the reliability of each. Choose a different station index number to those displayed.

7. If the receiver you are using supports transmission delays, the *Transmission delay* field appears. Choose a value depending on how many base stations you intend to use. For more information about transmission delays, see *Operating Several Base Stations on One Radio Frequency*, page 235.
8. Tap **Start**.
The base receiver starts to record data.
9. Do one of the following:
 - If you are carrying out a real-time survey or are logging data in the receiver, the following message appears:
Base started
Disconnect controller from receiver

Disconnect the TSCe data collector from the base receiver but **do not** turn off the receiver. You can now set up the rover receiver.

Note – For a real-time survey, check that the radio is working before leaving the equipment. The data light should be flashing.
 - If you are logging data in the TSCe data collector, the *Base* screen appears. It shows which point is being surveyed and the time that has elapsed since data logging started. Leave the TSCe data collector connected to the base receiver and set up the rover using another TSCe data collector.

Ending a Base Survey

After an RTK survey, or after logging data in the receiver, end the survey as follows:

1. Return to the equipment and select *Survey / End survey*. Tap to confirm that you want to end the survey, and again to power down the receiver.
2. Turn off the TSCe data collector.
3. Disconnect the equipment.

After logging base station data in the TSCe data collector, end the survey as follows:

1. Return to the equipment and tap .
2. Tap to confirm that you want to end the survey, and again to power down the receiver.
3. Turn off the TSCe data collector.
4. Disconnect the equipment.

Starting the Rover Receiver

In this chapter:

- Introduction
- Setting up the equipment for a real-time survey
- Setting up the equipment for a postprocessed Survey
- Setting up the equipment for a real-time and postprocessed Survey
- Starting a rover survey
- Starting a Wide-Area RTK Survey
- RTK initialization methods
- Recommended RTK initialization procedure
- Postprocessed initialization methods
- Swapping bases during a real-time rover survey
- Ending a rover survey

Introduction

This chapter shows you how to start the rover receiver for a GPS survey. It describes how to set up the equipment for use with different survey techniques.

You must initialize kinematic surveys to obtain centimeter-level precision. This chapter explains some common initialization methods, and recommends a method to use when initializing RTK surveys.

Note – When surveying with GPS, make sure that you still follow good survey practices. Revise and update your code of good survey practice regularly, and **always** check your work.

Setting Up the Equipment for a Real-Time Survey

This section shows how to assemble the hardware components at the rover receiver for a real-time kinematic (RTK) or real-time differential (RT differential) survey. Follow these steps if using a GPS Total Station 5700, 4800, or 4700 receiver.

Setting up a GPS Total Station 5700 Receiver

Figure 13.1 shows how to set up the GPS Total Station 5700 receiver.

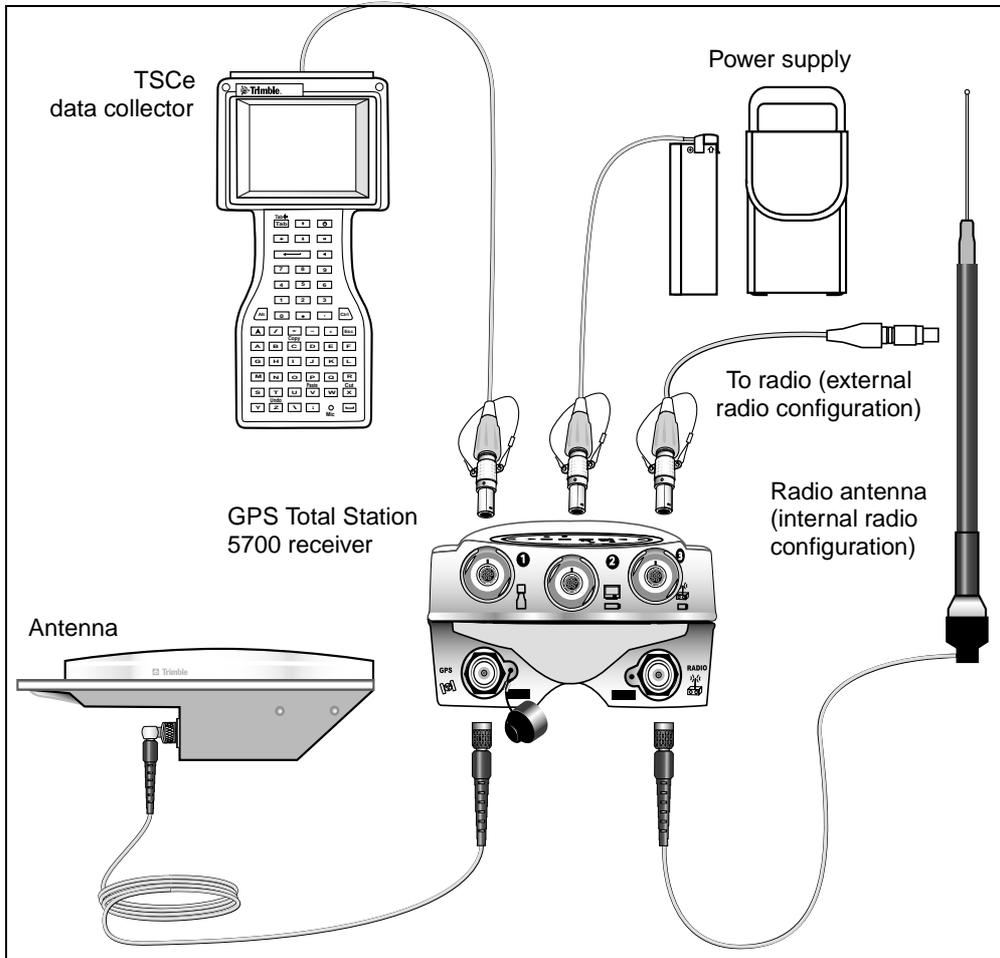


Figure 13.1 GPS Total Station 5700 receiver setup

To set up a rover receiver for a real-time survey using a Trimble GPS Total Station 5700 receiver and the internal radio:

1. Mount the Zephyr antenna on the range pole.
2. If you are using the Range Pole antenna (RPA), mount it on the range pole.
3. Use one of the following configurations to carry the GPS receiver:
 - For a pole-mounted setup, attach the receiver bracket to the pole and mount the receiver on the bracket.
 - For a backpack setup, insert the receiver into the backpack. If you are using a whip radio antenna, attach it to the fitting on the top of the backpack.
4. Connect the Zephyr antenna to the yellow GPS receiver port labeled “GPS”. Use the yellow GPS antenna cable (part number 41300-10).
5. Do one of the following:
 - If you are using the internal radio, connect the radio antenna to the GPS receiver port labeled “RADIO ANTENNA”.
 - If you are using an external radio, use the supplied radio cable to connect the radio to the GPS receiver port 3. Connect a radio antenna to the external radio.

Note – For some third-party radios, a separate power supply is needed for the radio.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

6. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
7. Turn on the TSCe data collector, then follow the instructions in Starting a Rover Survey, page 257.

Setting up a GPS Total Station 4800 Receiver

Figure 13.2 shows how to set up the rover equipment for both a real-time survey and a postprocessed survey.

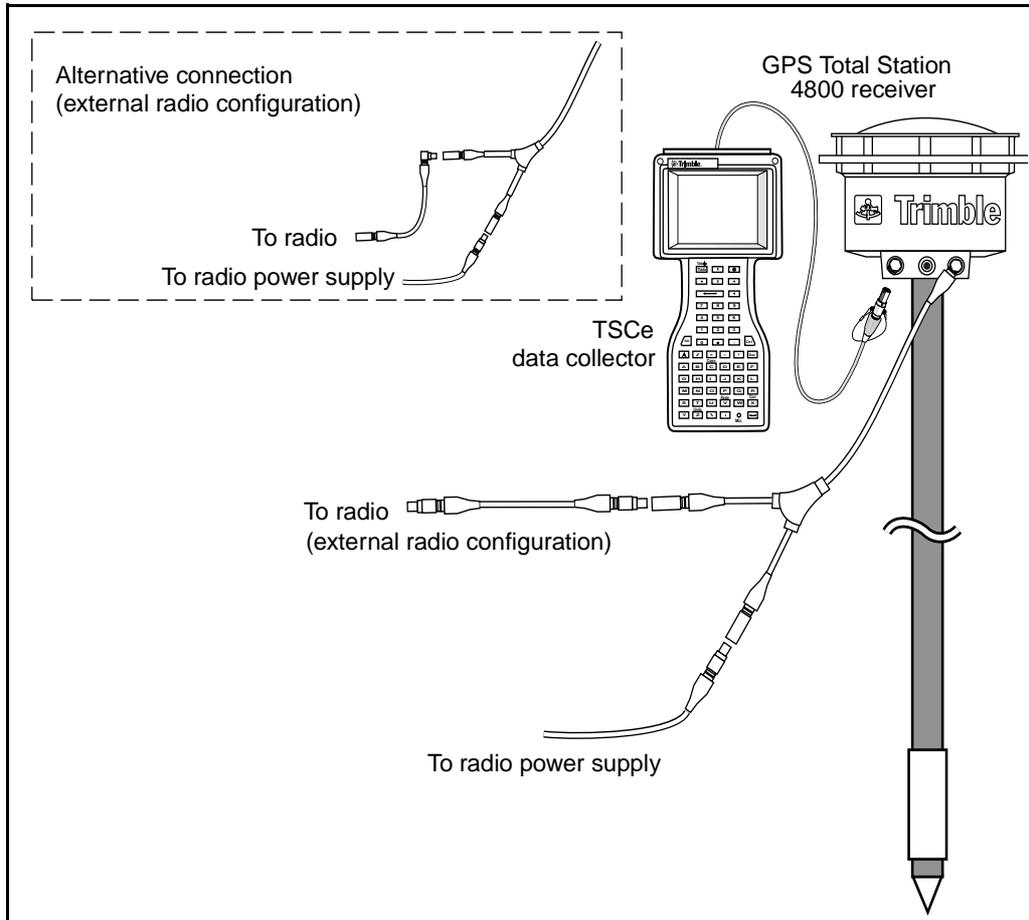


Figure 13.2 GPS Total Station 4800 receiver

To set up a rover receiver for a real-time survey using a GPS Total Station 4800 receiver:

1. Attach a battery to the PowerLiTE™ range pole.
2. Attach the GPS receiver to the range pole. Power for the Trimble 4800 receiver is supplied by the battery in the range pole.
3. If you are using an external radio, do the following:
 - a. Assemble the radio antenna and place the radio in a hip-pack or backpack.
 - b. Use the rover receiver Y-cable (part number 34382 or 37155, depending on the equipment) to connect the radio and its power supply to the GPS receiver port 3. Route the long end of the cable through the hip-pack before connecting it to the receiver. Connect the radio power supply and the radio cable to the two short ends in the hip-pack.
4. Connect the TSCe data collector to the GPS receiver port 1.
5. Turn on the TSCe data collector, then follow the instructions in *Starting a Rover Survey*, page 424.

Setting up a GPS Total Station 4700 Receiver

Figure 13.3 shows how to set up the rover receiver for a real-time survey using a GPS Total Station 4700 receiver.

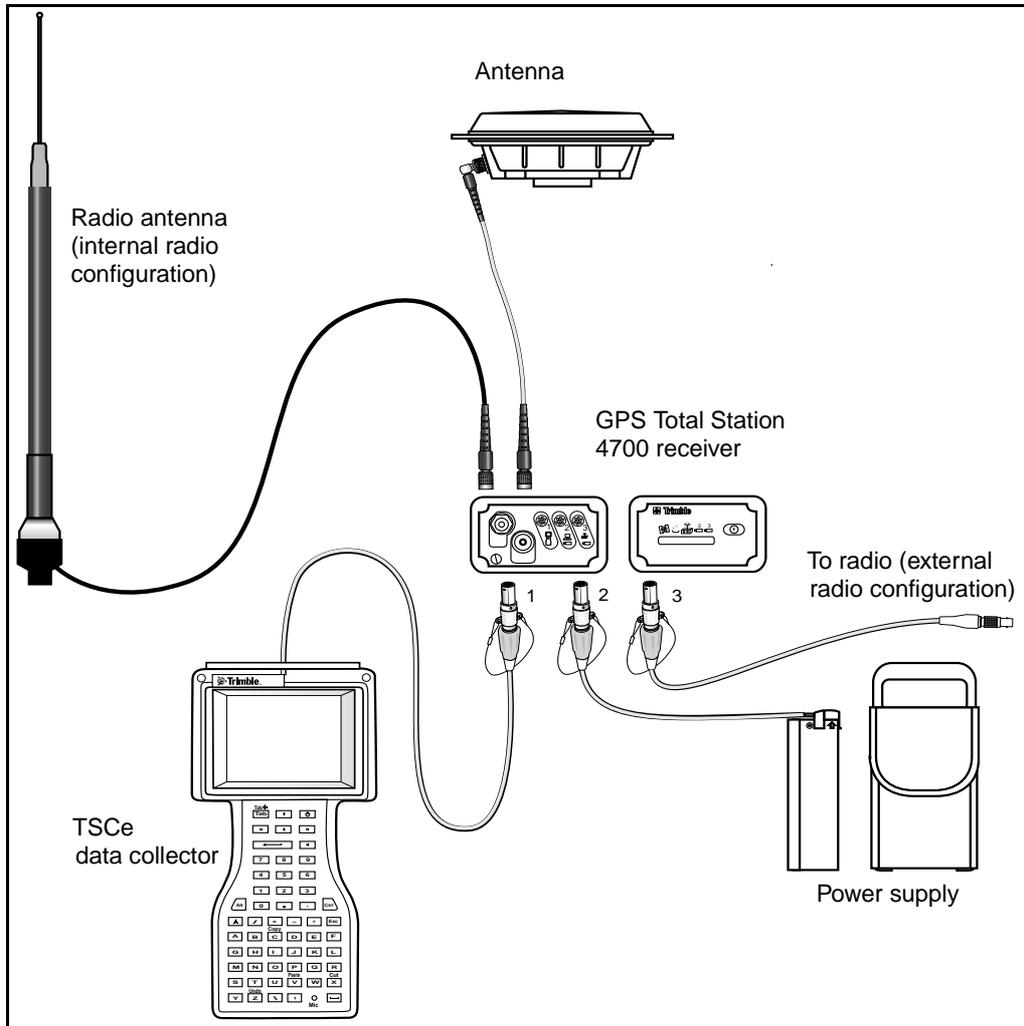


Figure 13.3 GPS Total Station 4700 receiver

To set up a rover receiver for a real-time survey using a Trimble GPS Total Station 4700 receiver and the internal radio:

1. Use a backpack to carry the GPS receiver, and mount the GPS antenna on a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled “GPS ANTENNA”. Use the N-type to Lemo co-axial cable.
3. Assemble the radio antenna and fix it to the outside of the backpack.
4. Do one of the following:
 - If you are using the internal radio, connect the radio antenna to the GPS receiver port labeled RADIO ANTENNA.
 - If you are using an external radio, use the supplied radio cable to connect the radio to the GPS receiver port 3. Connect a radio antenna to the external radio.

Note – For some third-party radios, a separate power supply is needed for the radio.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

5. Connect the power source to the GPS receiver port 2 and turn on the receiver.
6. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable and route it through the backpack.
7. Turn on the TSCe data collector, then follow the instructions in Starting a Rover Survey, page 257.

Setting Up the Equipment for a Postprocessed Survey

This section shows how to assemble the hardware at the rover receiver for a postprocessed kinematic (PP kinematic) survey or a FastStatic survey. It describes the steps for a Trimble GPS Total Station 5700, 4800, or 4700 receiver.

Using a GPS Total Station 5700 Receiver

To assemble the rover receiver hardware for a postprocessed survey, see Figure 13.1 on page 249. Then do the following:

1. Attach the Zephyr antenna to a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled “ANTENNA”. Use the N-type to Lemo co-axial cable.
3. Connect the Zephyr antenna to the yellow GPS receiver port labeled “GPS”. Use the yellow GPS antenna cable (part number 41300-10).



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

4. Connect the power source to the GPS receiver port 2 and turn on the receiver.
5. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
6. Turn on the TSCe data collector, then follow the instructions in Starting a Rover Survey, page 257.

Using a GPS Total Station 4800 Receiver

To assemble the rover receiver hardware for a postprocessed survey, see Figure 13.2 on page 251. Then do the following:

1. Attach a battery to the PowerLiTE range pole.
2. Attach the 4800 receiver to the PowerLiTE range pole and turn it on. The power is supplied from the battery in the range pole.
3. Connect the TSCe data collector to the GPS receiver port 1.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

4. Turn on the TSCe data collector, then follow the instructions in Starting a Rover Survey, page 257.

Using a GPS Total Station 4700 Receiver

To assemble the rover receiver hardware for a postprocessed survey, see Figure 13.3 on page 253. Then do the following:

1. Attach the GPS antenna to a range pole.
2. Connect the GPS antenna to the GPS receiver port labeled “ANTENNA”. Use the N-type to Lemo co-axial cable.



Warning – Do not force plugs into the receiver ports. Align the red dot on the plug with the red line on the socket and then insert the plug carefully.

3. Connect the power source to the GPS receiver port 2 and turn on the receiver.
4. Connect the TSCe data collector to the GPS receiver port 1. Use the 0-shell Lemo to 0-shell Lemo cable.
5. Turn on the TSCe data collector, then follow the instructions in Starting a Rover Survey, page 257.

Setting Up the Equipment for a Real-Time and Postprocessed Survey

A survey style such as RTK & infill uses both real-time and postprocessed techniques. To conduct this type of survey, assemble the rover exactly as for a real-time survey. If the receiver has no memory (or limited memory), leave the TSCe data collector connected to the base receiver for the purpose of data storage. You need another TSCe data collector for the rover receiver.

Starting a Rover Survey

Only start a survey after you have started the base receiver. For more information, see Chapter 12, *Starting the Base Receiver*.

To conduct a survey:

1. Make sure that the required job is open. The title of the main menu should be the current job name.
2. From the main menu, choose *Survey*. Select a survey style from the list. This must be the same survey style that you use for the base survey.

A *Survey* menu is generated. It displays items specific to the chosen survey style and includes the *Start base receiver* and *Start survey* items.

When you start a survey using a particular Trimble survey style for the first time, the Trimble Survey Controller software prompts you to customize the style for your specific hardware. For more information, see *The Style wizard*, page 197.

When the survey starts, the menu items *Start base receiver* and *Start survey* no longer appear. For kinematic surveys, a new item, *Initialization*, appears.

GPS Total Station 5700, 4800, or 4700 receiver

If the TSCe data collector is connected to a GPS Total Station 5700, 4800, or 4700 receiver that was logging data, the data logging stops. Data logging is restarted, in a different file, if you start a survey using a survey style that specifies data logging.

Note – When you start a survey, the Trimble Survey Controller software automatically negotiates the highest possible baud rate for communicating with the connected receiver.

Starting a Real-Time Rover Survey

To start the rover receiver for a real-time survey:

1. Select *Start survey*.
2. Make sure the rover is receiving radio corrections from the base.

Note – An RTK survey needs radio corrections.

3. If the receiver you are using supports transmission delays and you select the *Prompt for station index* check box in the *Rover options* field, the *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Highlight the base you want to use and tap .

For more information about using transmission delays, see *Operating Several Base Stations on One Radio Frequency*, page 235.



Tip – If you want to check the point name of the base station being used in the rover survey, select *Files / Review current job* and inspect the Base point record.

4. If necessary, initialize the survey.

For a differential survey, no initialization is necessary, and you can start to survey immediately. For more information, see Chapter 16, GPS Point Measurement.

Note – If you are carrying out an RTK survey but do not require centimeter-level results, select Survey / Initialization. Tap and set the Method field to No initialization.

For an RTK survey, initialize before starting centimeter-level surveying. If you are using a dual-frequency receiver with the OTF option, the survey automatically starts to initialize using the OTF initialization method.

5. When the survey is initialized, you can perform a site calibration, measure points, or stakeout.

Starting an RTK & Infill Rover Survey

Note – If you are using postprocessed techniques, to process the data you must have the Baseline Processing module of the Trimble Geomatics Office software installed.

To start the rover receiver for an RTK & infill survey:

1. Select *Start Survey*.
2. Make sure the rover is receiving radio corrections from the base.

Note – An RTK survey needs radio corrections.

3. If the receiver you are using supports transmission delays and the *Prompt for station index* check box in the *Rover options* option in the survey style is selected, the *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Highlight the base you want to use and tap .

For more information about using transmission delays, see *Operating Several Base Stations on One Radio Frequency*, page 235.



Tip – If you want to check the point name of the base station being used in the rover survey, select *Files / Review current job* and inspect the Base point record.

4. Initialize the survey using an RTK initialization method. For more information, see page 264.
5. Measure points as usual.

Switching to PP infill

During periods when no base corrections are received, the following message flashes in the status line:

Radio link down

To continue surveying select *Start PP infill* from the *Survey* menu. When postprocessing infill starts, this item changes to *Stop PP infill*.

Raw data is logged at the rover during postprocessing (PP) infill. For successful baseline resolution, you must now use postprocessed kinematic observation techniques.

Note – *Initialization cannot be transferred between the RTK survey and the PP infill survey. Initialize the PP infill survey like any other postprocessed kinematic survey. For more information, see Postprocessed Initialization Methods, page 267.*

Only rely on the OTF (automatic) initialization if you are certain that the receiver will observe at least five satellites, without interruption, for the next 15 minutes. Otherwise, select *Initialization* from the *Survey* menu and perform an initialization.

Note – *You cannot stake out points during a postprocessed survey.*

When base corrections are received again, one of the following messages appears in the status line, depending on the initialization mode of the RTK survey:

- Radio link up (RTK=Fixed)
- Radio link up (RTK=Float)

The first message is displayed if the receiver has retained the RTK initialization during the PP infill survey. That is, if the number of satellites did not fall below four throughout the PP infill survey.

Select *Stop PP infill* from the *Survey* menu to stop data logging at the rover. When postprocessing infill stops, this item changes back to *Start PP infill*. Real-time measurements are resumed.

Starting a Postprocessed Rover Survey

To start the rover receiver for a postprocessed survey, select *Start survey*.

Note – *If using postprocessed techniques, to process the data you must have the Baseline Processing module of the Trimble Geomatics Office software installed.*

You can begin surveying immediately, you do not need to initialize a FastStatic or differential survey. For more information, see Chapter 16, GPS Point Measurement.

You must initialize a PP kinematic survey to achieve centimeter-level precisions when the data is processed. With dual-frequency receivers, the initialization process begins automatically if at least five L1/L2 satellites are being observed.

For more information about initializing a postprocessed survey, see Postprocessed Initialization Methods, page 267. For information about measuring points, see Chapter 16, GPS Point Measurement.

Working in Float mode

Work in Float mode if you do not want to initialize a survey. Start the survey and select *Initialization*. When the *Initialization* screen appears, press . Set the *Method* field to *No initialization* and tap .

Starting a Wide-Area RTK Survey

Wide Area RTK (WA RTK) systems consist of a distributed network of reference stations communicating with a control center to calculate GPS error corrections over a wide area. Real-time correction data is transmitted by radio or cellular modem to the rover receiver within the network area.

The system improves reliability and operating range by significantly reducing systematic errors in the reference station data. This lets you increase the distance at which the rover receiver can be located from the physical reference stations, while improving on-the-fly (OTF) initialization times.

The Trimble Survey Controller software supports broadcast formats from the following WA RTK solutions:

- SAPOS FKP
- Virtual Reference Station (VRS)
- CMRNet

To use a WA RTK system, first check that you have the necessary hardware and firmware.

Hardware Requirements

All rover receivers must have firmware that support WA RTK. For details of availability, check the Trimble website or contact your local dealer.

Real-time correction data is provided by radio or cellular modem. For details about the delivery option for your system, contact your local dealer.

Configuring the Survey Style

Before you start a survey using a WA RTK system, configure the RTK survey style.

To select a WA RTK broadcast format:

1. In the survey style, select *Rover options*.
2. In the *Broadcast format* field, select one of the following options from the list:
 - SAPOS FKP
 - VRS
 - CMRNet

To select a radio solution:

1. In the survey style, select *Rover options*.
2. In the *Type* field, select your radio from the list.

Note – *If you are using a radio in a VRS system, you must select a two-way radio. You cannot use Trimble internal radios.*

Starting a Rover Survey

Starting a rover survey is the same as for a real-time survey. For more information, see page 258.

To start a survey using VRS or SAPOS FKP, you must send an approximate position for the rover receiver to the control station. When you start the survey, this position is automatically sent through your radio communications link in a standard NMEA position message. It is used to compute the RTK corrections your receiver will use.

RTK Initialization Methods

If base corrections are being received and there are four or more satellites, the survey is initialized automatically when you start the survey. A survey must be initialized before centimeter-level surveying can begin.

Note – At least five L1/L2 satellites are required for OTF initialization. After initialization, at least four satellites must be tracked. If the number of satellites drops below four, the survey must be reinitialized.

Table 13.1 summarizes methods of initializing a real-time kinematic survey, and the time required for each method.

Table 13.1 Initializing a Real-Time Kinematic survey

Survey and receiver type	Time required for each initialization method		Range (km)
	Known Point	OTF	
RTK	~15 s (5+ SVs)	~60 s, 5+ SVs	<10
Dual-frequency (OTF)	~30 s (4 SVs)		

Note – Initialization must be maintained throughout the survey by continuously tracking a minimum of four satellites. If initialization is lost at any time, reinitialize and then continue the survey.

After initialization, the survey mode changes from Float to Fixed. The mode remains Fixed if the receiver continuously tracks at least four satellites. If the mode changes to Float, reinitialize the survey.

Multipath

Initialization reliability depends on the initialization method used and on whether or not multipath occurred during the initialization phase. Multipath occurs when GPS signals are reflected off objects, such as the ground or a building.

The occurrence of multipath at the GPS antenna adversely affects GPS initializations and solutions:

- If initialization is by the Known Point method, multipath can cause an initialization attempt to fail.
- If initialization is by the OTF method, it is difficult to detect the presence of multipath during the initialization. If there is multipath, the receiver may take a long time to initialize or it may not initialize at all. For more information, see Recommended RTK Initialization Procedure, page 266.

The initialization process in Trimble receivers is very reliable, but if an incorrect initialization does occur, Trimble's RTK processing routines detect it within 15 minutes (if the mode has remained Fixed). When the error is detected, the receiver automatically discards the initialization and issues a warning.

Note – If you survey points with a bad initialization, you will get position errors. To minimize the effect of multipath during an OTF initialization, move around.

Known Point Initialization

To perform a Known Point initialization:

1. Position the rover antenna over a known point.
2. From the *Survey* menu, choose *Initialization*.

3. Set the *Method* field to *Known Point*.
4. Access the *Point name* field and tap . Select the point from the list of known points.
5. Enter values in the *Code* and *Antenna height* fields, and make sure that the setting in the *Measured to* field is correct.
6. When the antenna is centered and vertical over the point, tap .

The data collector starts to record data, and the static icon () appears in the status bar.

Keep the antenna vertical and stationary while data is recorded.
7. When the receiver is initialized, the following message appears:

Initialization change. Initialization has been gained.

The results are displayed. Tap to accept the initialization.
8. If the initialization fails, the results are displayed. The Trimble Survey Controller software asks if you want to retry. Tap or .

Recommended RTK Initialization Procedure

This section describes the procedure that Trimble recommends for performing a check on an OTF RTK initialization.

Minimize the chance of surveying with a bad initialization by adopting good survey techniques. A bad initialization occurs when the integer ambiguities are not correctly resolved. The Trimble Survey Controller software automatically reinitializes when this is detected, but cannot do so if you end the survey too soon. As a precaution, always perform the RTK initialization described below.

When initializing, always choose a site that has a clear view of the sky and is free of obstructions that could cause multipath.

***Note** – Known Point is the quickest method of initialization when known points exist.*

To perform an On-The-Fly initialization:

1. Initialize the survey using the OTF method of initialization.



Tip – When performing an OTF initialization, move around to reduce the effect of multipath.

2. When the system is initialized, establish a mark about 9 meters (30 feet) from where the initialization occurred.
3. Conduct a static point measurement over the mark. Once this is done, discard the current initialization.
4. If you are using an adjustable height range pole, change the height of the antenna by approximately 8 inches.
5. Reoccupy the mark observed in step 2, and reinitialize the survey using either the OTF or Known Point method of initialization. Remember to enter the new antenna height details.

Follow this procedure to substantially improve the quality of an initialization.

Measuring a new point creates a known point on which the first initialization is tested. Changing the antenna height moves the GPS antenna from the environment in which the test point was initially surveyed. Always enter the new antenna height before starting the Known Point initialization.

Postprocessed Initialization Methods

In a postprocessed survey you must initialize to attain centimeter-level precisions.

Use one of the following methods to initialize dual-frequency postprocessed kinematic surveys in the field:

- On-The-Fly
- Known Point

Note – In a postprocessed survey, collect enough data during initialization so that the WAVE™ processor can successfully process it. Table 13.2 shows Trimble’s recommended times.

Table 13.2 Trimble PP Kinematic initialization times

Initialization method	4 SVs	5 SVs	6+ SVs
L1/L2 OTF initialization	N/A	15 min	8 min
Known Point initialization	at least four epochs		

After initialization, the survey mode changes from Float to Fixed. The mode remains Fixed if the receiver continuously tracks at least four satellites. If the mode changes to Float, reinitialize the survey.

Note – If you do an On-The-Fly initialization in a postprocessed kinematic survey, it is possible to measure points before initialization is gained. The Trimble Geomatics Office software can back-process the data later to give a fixed solution. If you do this but lose lock on the satellites while initializing, re-measure any one of the points that you surveyed before lock was lost.

To work without initializing the survey (in Float mode), start a survey and select *Initialization*. When the *Initialization* screen appears, tap . Set the *Method* field to *No initialization* and tap .

Known Point Initialization

In a postprocessed survey you can initialize on:

- a point measured previously in the current job
- a point that you will provide coordinates for later (before the data is postprocessed)

For instructions on how to do a Known Point initialization, see page 265.

Swapping Bases During a Real-Time Rover Survey

If you are using multiple bases on the same frequency, you can swap bases during the rover survey. For more information, see *Operating Several Base Stations on One Radio Frequency*, page 235.

To swap bases, do the following:

- From the *Survey* menu, select *Swap base receiver*.

The *Select base station* screen appears. It shows all the base stations operating on the frequency you are using. The list shows the station index numbers of each base and the reliability of each. Tap the base you want to use.

Note – When you change to a different base, your OTF receiver automatically starts the initialization.

Ending a Rover Survey

When you have measured or staked out all points required, do the following:

1. From the *Survey* menu, choose *End survey*.

The Trimble Survey Controller software asks if you want to power down the receiver. Tap **Yes** to confirm this.

2. Turn off the TSCe data collector *before* disconnecting the equipment.
3. Return to the base station and end the base survey. For more information, see *Ending a Base Survey*, page 246.

Calibration

In this chapter:

- Introduction
- When to calibrate
- Notes and recommendations
- Performing a manual site calibration
- Using auto calibrate

Introduction

This chapter shows you how to perform both manual and automatic calibrations in the field. Before reading the chapter, you should be familiar with Chapter 2, Coordinate Systems. There is also useful information about base station coordinates in the section on Base Station Coordinates, page 224.

When to Calibrate

For a GPS survey, or a survey that combines GPS measurements and conventional measurements with local control points, always complete a calibration *before* staking out any points, or computing offset or intersection points.

For a survey that uses conventional measurements only, no calibration is required.

Notes and Recommendations

- You can perform a calibration using one of the real-time GPS survey styles in the Trimble Survey Controller software. Do this manually, or let the Trimble Survey Controller software do it automatically. If all the points have been measured, you do not need to connect the TSCe data collector to a receiver during a manual calibration.
- Multiple calibrations can be performed in one job. The last calibration performed and applied is used to convert the coordinates of all previously surveyed points in the database.
- You can use up to 20 points for a calibration. Trimble strongly recommends that you use a minimum of four 3D local grid coordinates (N, E, E) and four observed WGS-84 coordinates, with the local projection and datum transformation parameters (the coordinate system). This should provide enough redundancy.

Note – You can use a combination of 1D, 2D, and 3D local grid coordinates. If no projection and no datum transformation are defined, you must have at least one 2D grid point.

If you did not specify the coordinate system, the Trimble Survey Controller software calculates a Transverse Mercator projection and a three-parameter datum transformation.

- Use the Trimble Geomatics Office software, Trimble’s Data Transfer utility, or ASCII transfer to transfer control points.
- Be careful when naming points that are to be used in a calibration. Before you begin, familiarize yourself with the database search rules on page 423.
- The set of WGS-84 coordinates must be independent of the set of grid coordinates.
- You select the grid coordinates. Select the vertical coordinates (elevation), the horizontal coordinates (northing and easting values), or all of these together.
- Place the calibration points around the perimeter of the site. Do not survey outside of the area enclosed by the calibration points, as the calibration is not valid beyond this perimeter.
- The origin of the horizontal adjustment in a calibration is the centroid of the measured calibration points. The origin of the vertical adjustment is the first point in the calibration with an elevation.
- When reviewing a calibration point in the database, notice that the WGS-84 values are the *measured* coordinates. The grid values are derived from these, using the current calibration.

The original keyed-in coordinates remain unchanged. (They are stored elsewhere in the database as a point with the *Type* field showing *Keyed in coordinates* and the *Stored as* field showing *Grid*.)

- When you are calibrating a no projection, no datum job, (where ground coordinates are required after calibration) you must define the project height (average site height). When the job is calibrated, the project height is used to compute a ground scale factor for the projection, using the inverse of the ellipsoid correction.
- When you have calibrated a scale-only job, the scale factor that you specified in the job is used as the scale factor in the projection.

Performing a Manual Site Calibration

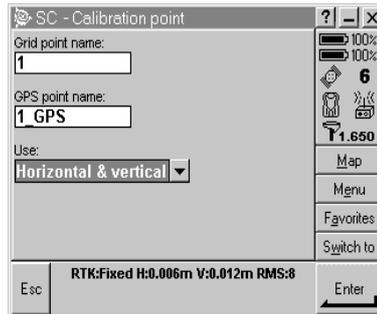
To calibrate a survey manually:

1. Key in, transfer, or use a conventional instrument to measure the grid coordinates of the control (calibration) points.
2. Check or enter the calibration tolerances. For more information, see Site Calibration, page 210.
3. Use GPS to measure the control points.
4. Name or select the pairs of points to be used for the calibration. A pair of points consists of the grid coordinates and the WGS-84 coordinates for the same point.
5. Perform the calibration.
6. Check residuals, and recalibrate if necessary.
7. Apply the calibration.

Note – Before starting a manual calibration, read Notes and Recommendations, page 272.

The following steps describe how to select the points for a calibration and then perform the calibration using the Trimble Survey Controller software. Do this once you have entered grid coordinates, checked the settings in the Survey Style, and measured the points using GPS.

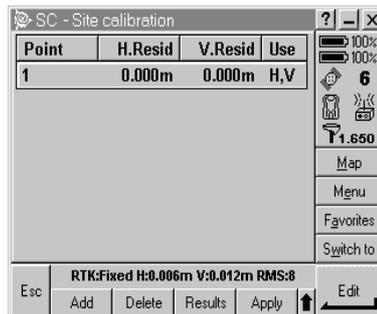
1. From the main menu, choose *Survey*. Select a real-time survey style.
2. From the *Survey* menu, choose *Site calibration*. The *Site calibration* screen appears.
3. Tap **Add**. The following screen appears:



4. Enter the name of the grid point. To do this, highlight the *Grid point* field and tap **List**. Select a point that you have keyed in, transferred, or measured using a conventional instrument. Do the same for the *GPS point* field. The two point names do not have to be the same, but they should correspond to the same physical point.

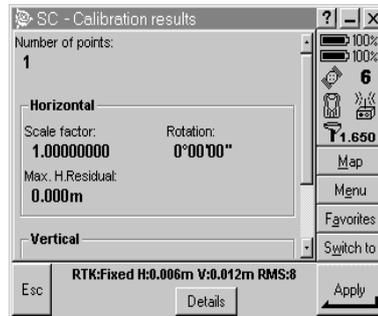
In the *Use* field, choose whether to use the vertical coordinate of the grid point, the horizontal coordinates, or both horizontal and vertical coordinates.

5. Tap **Enter**. The following screen appears:



The residuals for each point are not displayed until at least three 3D points are included in the calibration to provide redundancy.

6. Tap **Results** to see the horizontal and vertical shifts that the calibration has calculated. The following screen appears:



7. To add more points, tap **Esc** to return to the calibration screen.
8. Repeat steps 3 through 6 until all the points are added.
9. Do one of the following:
 - If the residuals are acceptable, tap **Apply** to store the calibration.
 - If the residuals are not acceptable, recalculate the calibration.

Recalculating a Calibration

Recalculate a calibration if the residuals are not acceptable, or if you want to add or delete points. Recalculate using one of the following:

- some of the points
- only the horizontal component of a point
- only the vertical component of a point

To recalculate a calibration:

1. From the main menu, select *Survey*. Then select a real-time survey style.
2. From the *Survey* menu, choose *Site calibration*.
3. Do one of the following:
 - To remove (exclude) a point, highlight the point name and tap .
 - To add a point, tap . For more information, see step 4 on page 275.
 - To change the components used for a point, highlight the point name and tap . In the *Use* field, choose whether to use the vertical coordinate of the grid point, the horizontal coordinates, or both horizontal and vertical coordinates.
4. Tap to apply the new calibration.

Note – *Each calibration calculation is independent of the previous one. When a new calibration is applied, it overwrites any previously calculated calibration.*

Using Auto Calibrate

A calibration calculates the parameters needed to convert the GPS-measured coordinates into local grid coordinates. During an RTK survey, the Trimble Survey Controller software does this automatically. When you use the auto calibrate function, it automatically computes and stores a calibration every time a calibration point is measured.

To calibrate a survey automatically:

1. Key in, transfer, or use a conventional instrument to measure the grid coordinates of the local control points.
2. Select the *Auto calibrate* check box.

3. Use GPS to measure the calibration points.

The first three steps complete the automatic calibration.

The following steps are optional:

1. Inspect the calibration results.
2. Change the results if they are unsatisfactory.

***Note** – Carry out the complete calibration **before** staking out any points, computing offset and/or intersection points, or computing a resection from GPS points.*

Keying In Grid Coordinates

To key in grid coordinates:

1. From the main menu, select *Key in / Points*. The *Point* screen appears.
2. Enter the point name in the *Point name* field. Tap .
3. Enter details or features of the point in the *Code* field. Tap .
4. In the *Method* field, select *Coordinates*. Check that the coordinate fields are *North*, *East*, and *Elevation*. If they are not, tap and change the *Coordinate view* to *Grid*. Key in the known grid coordinates and tap .
5. Select the *Control point* check box. (This ensures that the point is not overwritten by a measured point.)
6. Repeat steps 2 and 3 for all grid coordinate points. Then tap to return to the main menu.

Transferring Grid Coordinates

Transfer coordinates using the Trimble Geomatics Office software, the Data Transfer utility, or ASCII transfer. For more information, see Data Transfer between the TSCe Data Collector and the Office Computer, page 68.

Make sure that these coordinates are:

- transferred as grid coordinates (N, E, E), not as WGS-84 coordinates (L, L, H)
- control class points

Using a Conventional Instrument to Measure Grid Points

For information, see Station Setup, page 345.

Selecting Automatic Calibration

To select Auto calibrate:

1. From the main menu, choose *Configuration / Survey Styles*. The *Survey Styles* menu appears.
2. Highlight your RTK survey style and tap .
3. Select *Site calibration*. The *Site calibration* screen appears.
4. Select the *Auto calibrate* check box. For more information on changing the calibration tolerances, see Site Calibration, page 210. Tap to accept the screen. The menu for the selected survey style appears.
5. Tap to accept the changes and return to the main menu.

Using GPS to Measure Calibration Points

Use GPS to survey the points. The Trimble Survey Controller software automatically matches the grid points to the WGS-84 values and then calculates, stores, and applies the calibration.

When one point has been calibrated, or a projection and datum transformation have been defined, the softkey appears. You can use this to navigate to the next point.

As you measure another calibration point, the new calibration is calculated, stored, and applied to the job.

To measure a calibration point:

1. From the main menu, choose *Survey*.
2. Highlight your RTK survey style and select *Measure points*. The *Measure points* screen appears.
3. In the *Method* field, select Calibration point.
4. Access the *Grid point name* field and tap . A list of keyed-in grid coordinates appears. Highlight the point to be measured and tap . The point name is inserted into the *Grid point name* field.



Tip – If you have not yet keyed in the grid coordinates for this point, tap while the cursor is in the *Point name* field. The *Point* screen appears. Enter the coordinates and then tap .

The Trimble Survey Controller software enters the *GPS point name* according to the selected *Site calibration / Calibration point name* option in the survey style.

5. Enter values for the *Code* and *Antenna height* fields.
6. When the antenna is centered and vertical over the control point, tap . The data collector starts to record data.
Keep the antenna vertical and stationary while data is recorded.
7. When the preset required time has elapsed, and the precisions are satisfactory, tap to store the point.

The calculations are then done automatically and the results are stored.

Note – When the Trimble Survey Controller software is performing an automatic calibration, the results of the calibration are not normally displayed. However, if a calibration exceeds the tolerances that have been set, the residuals **are** displayed. For more information, see the next section.

8. Enter the next calibration point name in the *Point name* field and tap . The graphical display screen appears, with the azimuth and distance to the next point displayed on the right.

To use the arrow display, start moving forward with the data collector held in front of you as normal. The arrow points in the direction of the next calibration point. Walk towards the point. About 10 feet (3 meters) from the point, the arrow disappears and the point is displayed. For more information, see Using the Graphical Display to Navigate, page 310.

When the point is located, tap .

9. Repeat steps 4 through 8 until all the calibration points are measured.

If Calibration Tolerances Are Exceeded

The calibration residuals are only displayed if the calibration tolerances are exceeded, as shown in the following screen:

Point	H.Resid	V.Resid	Use
Nail B	0.238m	0.079m	H,V
Nail C	1.354m	0.070m	H,V
TRS	0.812m	0.243m	H,V
Nail A	2.160m	0.234m	H,V

RTK:Fixed H:0.010m V:0.014m RMS:15

Map Menu Favorites Switch to Edit

If this happens, consider removing the point with the most extreme residuals. Do one of the following:

- If at least four points are left after removing that point, recalibrate using the remaining points.
- If not enough points are left after removing that point, measure it again and recalibrate.

It may be necessary to remove (re-measure) more than one point. To remove a point from the calibration calculations:

1. Highlight the point name and tap .
2. In the *Use* field, select *Off* and tap . The calibration is recalculated and the new residuals are displayed.
3. Tap to accept the calibration.

Inspecting the Results of an Automatic Calibration

To view the results of an automatic calibration:

1. From the *Survey* menu, choose *Site calibration*. The *Site calibration* screen appears.
2. Tap to see the *Calibration results* screen. For more information, see *Calibration Results* screen on page 276.

Changing the Results of an Automatic Calibration

To change a calibration that has been calculated using the *Auto calibrate* function, select *Site calibration* from the *Survey* menu. Then proceed as described in *Performing a Manual Site Calibration*, page 274.

GPS Instrument Menu

In this chapter:

- Introduction
- Satellites
- Position
- Copy Receiver files
- Receiver status
- Options
- Navigate to point

Introduction

The *Instrument* menu provides information about the instrument that is connected to the TSCe data collector. This menu appears when you choose the *Instrument* icon from the main menu.

If a GPS receiver is connected to the TSCe data collector, the items in the *Instrument* menu are:

- Satellites
- Position
- Receiver files (optional—according to which receiver you use)
- Receiver status
- Options
- Navigate to point

Satellites

From the main menu, select *Instrument / Satellites*. The *Satellites* screen displays text (list) or graphical (plot) information about the satellites being tracked by the receiver.



Tip – You can also access the *Satellites* screen from the status bar by tapping the satellite icon.

Satellite List Screen

In the list of satellites, each horizontal line of data relates to one satellite. A satellite is identified by the space vehicle number in the *SV* column. Azimuth (*Az*) and elevation (*Elev*) define a satellite's position in the sky. The signal-to-noise ratios (*SNRL1* and *SNRL2*) indicate the strength of the respective GPS signals. The greater the number, the better the signal. If L1 or L2 are not being tracked, then a dashed line (----) appears in the appropriate column.

The check mark on the left of the screen indicates whether the satellite is in the current solution, as shown in Table 15.1.

Table 15.1 Explanation of check marks

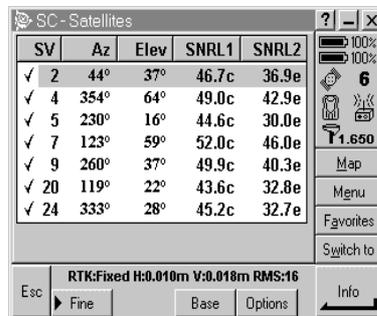
Situation	What a check mark indicates
No survey is running	Satellites being used in the current position solution
RTK survey is active	Satellites common to the base and rover receivers
Postprocessed survey is running	Satellites for which one or more epochs of data have been collected

To obtain more information about a satellite, tap the appropriate line.

In the *Satellites / Info* screen, tap **Prev** or **Next** to select the desired satellite. To disable the tracking of satellites, tap **Disable**. When a satellite is disabled in this way, the **Disable** softkey changes to **Enable**. Tap it to enable the satellite again.

Note – If you disable a satellite, it remains disabled until you enable it again. The receiver stores the fact that a satellite is disabled, even when it is turned off. WAAS satellites cannot be disabled.

A typical satellite list screen appears as follows:



In a real-time survey, tap **Base** to see which satellites are being tracked by the base receiver. No values appear in the *Az* and *Elev* columns, as this information is not included in the correction message broadcast by the base.

In a postprocessed survey, **L1** appears. Tap it to display a list of cycles tracked on the L1 frequency for each satellite.

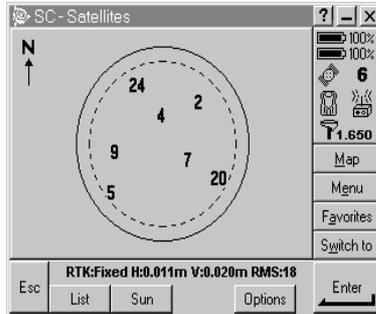
The value in the *CntL1* column is the number of cycles on the L1 frequency that have been tracked continuously for that satellite. The value in the *TotL1* column is the total number of cycles that have been tracked for that satellite since the start of the survey.

With a dual-frequency receiver, **L2** appears. Tap it to display a list of cycles tracked on the L2 frequency for each satellite.

The **SNR** softkey appears. Tap it to return to the original screen and view information about the signal-to-noise ratio for each satellite.

Satellite Plot Screen

Use **Plot** and **List** to switch between the list and plot screens. A typical plot screen appears as follows:



In the plot screen:

- The outside circle represents the horizon or 0° elevation.
- The inner dashed circle represents the elevation mask setting.

- The SV numbers on the diagram are placed in the position of that particular satellite.
- The zenith (90° elevation) is the center of the circle.
- Satellites that are tracked but not in the solution appear in reverse video (white on black).

Double-tap an SV number to obtain more information about the satellite.

The plot screen can be oriented towards north, or towards the sun if you do not know where north is. Tap to orient the display towards the sun.

Position

From the main menu, select *Instrument / Position*.

If the antenna height is defined, the software computes the position of the roving antenna:

- Tap to display the position of the base antenna as well.
- Tap to determine whether the position is shown as WGS-84, local, or grid.

Copy Receiver Files

This option is available when a GPS Total Station 5700, 4800, or 4700 receiver is in use. Use this option to copy and delete files in the connected receiver.

If you are connected to a 5700 receiver, you can export files stored on the TSCe data collector to the survey data card on the receiver.

To import receiver files from the connected receiver to the Trimble Survey Controller software:

1. From the main menu, select *Instrument / Receiver files / Import from receiver*. The *Import from receiver* list appears. This lists all files stored in the receiver.
2. Tap the file(s) that you want to import. A checkmark appears next to the selected files.

Note – To see more information about a file, highlight the file name and tap . To delete a file, highlight the file name and tap .

3. Tap . The *Copy file to TSCe* screen appears.
4. Tap to copy the files.
5. When the files have been copied the following message appears:

Completed successfully

To export files to the Trimble 5700 receiver:

1. From the main menu, select *Instrument / Receiver files / Export to receiver*.

The *Export to receiver* list appears. This lists all files stored in the \Trimble Data folder in the TSCe data collector.

2. Tap the file(s) that you want to export. A checkmark appears next to the selected files. Tap .
3. Tap to copy the files.
4. When the files have been copied the following message appears:

Completed successfully

Receiver Status

From the main menu, select *Instrument / Receiver status*.

The screen displays the power and memory status of the connected GPS receiver, the GPS time (in seconds), and the GPS week.

Options

From the main menu, select *Instrument / Options*.

The screen displays the configuration of the connected GPS receiver. It includes information such as the serial number, the firmware version, and hardware and firmware options.

Navigate to Point

It is not essential to have a radio link or a survey running to navigate to a point. If there is no radio link, all positions are autonomous. If radio corrections are received but the receiver is not initialized, all positions are Float solutions.

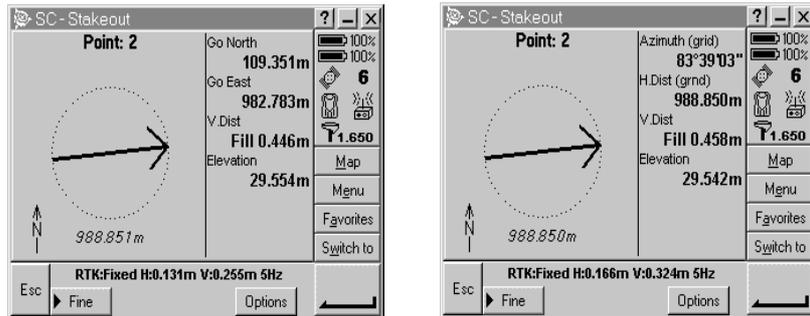
If you are using a GPS receiver that can track WAAS signals, when the radio link is down you can use WAAS positions instead of autonomous positions. To use WAAS positions, set the *WAAS* field in the survey style to *On*.

To navigate to a point:

1. Do one of the following:
 - From the main menu, select *Instrument / Navigate to point*. In the *Point name* field, enter the name of the point that you want to navigate to.
 - From the map, tap and hold on the point you want to navigate to. A shortcut menu appears. Select the *Navigate to point* option.
2. Set the *Navigate* field. The options are: *To the point*, *From fixed point*, and *From start position*. The *From fixed point* and *From start position* options both provide cross-track information in the graphical screen display. For more information see, *Using the Graphical Display to Navigate*, page 310.

- Enter a value in the *Antenna height* field and tap **Start**. The stakeout graphical screen display appears. The coordinate differences are displayed, together with a graphical representation of this.

The following screens show the graphical display with grid deltas displayed (left screen) and not displayed (right screen):

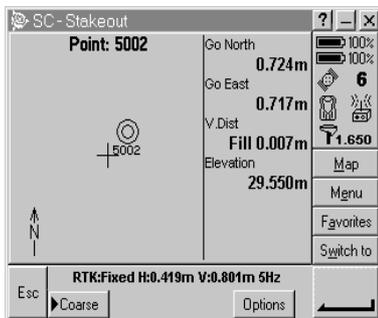


- Use the graphical display or the text display to navigate to the point.

To use the arrow as a guide, hold the data collector in front of you as normal and start moving forward towards the point. The arrow points in the direction of the point to be staked out.

The direction arrow only works correctly when you are moving **forward** and holding the data collector in front of you. In a real-time survey, the display updates one position per second or five positions per second, depending on the equipment used. If you are not sure how to use the arrow, use the text side of the display to locate the point. For more information, see Fine and Coarse Modes, page 309.

About 10 feet (3 meters) from the point, the arrow disappears and the point is shown as a bull's-eye symbol. Your current position is shown as a cross. When the cross covers the bull's-eye, check the precisions and mark the point if required. The following screen shows the display in fine mode:



When the screen display changes in this way, the orientation of the display is fixed.

GPS Point Measurement

In this chapter:

- Introduction
- Measuring a topo point in a GPS survey
- Measuring a FastStatic point
- Measuring an observed control point
- Measuring a Rapid point
- Measuring continuous topo points
- Measuring an as-staked point
- Measuring a laser point
- Measuring a calibration point
- Measuring a check point
- Next free point name search
- Storing Points

Introduction

In a GPS survey, you measure points by choosing one of several predefined point types.

The survey style (and so the survey type) you choose determines the type of point(s) that can be measured. A single survey style cannot measure every kind of point, so it is necessary to use different survey styles to measure different kinds of point. For example, an RTK survey style can be used to measure observed control points, Rapid points, topo points, and calibration points, but to measure a FastStatic point, you must use a FastStatic survey style. For more information, see Chapter 10, GPS Survey Styles.

This chapter shows you how to change some survey options, how to measure different types of point, and also explains the quality control records that are stored when you measure a point using GPS.

Note – For RTK surveys, initialize the survey before measuring points.

Measuring a Topo Point in a GPS Survey

You can measure a topo point in every type of survey except a FastStatic survey.

To measure a topo point:

1. Do one of the following:
 - From the main menu, select *Survey / Measure points*.
 - Tap **Favorites** and select *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the *Code* field entry is optional), and select Topo point in the *Type* field.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Measured to* field is set appropriately.
4. When the antenna is vertical and stationary, tap **Measure** to start recording data. The static icon appears in the status bar.

5. When the preset occupation time and precisions have been reached, tap  to store the point.



Tip – In the survey style, select the *Auto store point* check box to automatically store the point when the preset occupation time and precisions have been met.

Measuring a FastStatic Point

You can only measure a FastStatic point in a FastStatic survey.

Note – *FastStatic surveys are postprocessed and do not need to be initialized.*

To measure a FastStatic point:

1. Do one of the following:
 - From the main menu, select *Survey / Measure points*.
 - Tap  and select *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the *Code* field entry is optional).
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Measured to* field is set appropriately.
4. Tap  to start measuring the point.
5. When the preset occupation time is reached, as shown in Table 16.1, tap  to store the point.

Table 16.1 Trimble FastStatic occupation times

Receiver type	4 SVs	5 SVs	6+ SVs
Single-frequency	30 min	25 min	20 min
Dual-frequency	20 min	15 min	8 min

Tip – No satellite tracking is necessary between measuring points. You can turn off the equipment.

Measuring an Observed Control Point

When the Trimble Survey Controller software measures an observed control point, it stores a point when the preset number of epochs has elapsed and the precisions have been attained.

To measure an observed control point:

1. Do one of the following:
 - From the main menu, select *Survey / Measure points*.
 - Tap **Favorites** and select *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the *Code* field entry is optional), and select *Observed control point* in the *Type* field.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Measured to* field is set appropriately.
4. Tap **Measure** to start recording data.
5. When the preset number of epochs and precisions are reached, tap **Store** to store the point.

Note – *For an RTK survey, initialize the survey before starting to measure the point. For a Postprocessed Kinematic survey, you can start measuring a point, but you cannot store it until you have initialized the survey.*

Measuring a Rapid Point

A Rapid point is stored when the preset precisions are attained. There is no minimum occupation time, and point storage is automatic.

To measure a Rapid point:

1. Do one of the following:
 - From the main menu, select *Survey / Measure points*.
 - Tap **Favorites** and select *Measure points*.
2. Enter values in the *Point name* and *Code* fields (the *Code* field entry is optional), and enter *Rapid point* in the *Type* field.
3. Enter a value in the *Antenna height* field and make sure that the setting in the *Measured to* field is set appropriately.
4. Tap **Measure** to start recording data. The point is automatically stored when the preset precisions are reached.

Note – When using WAAS positions in a survey, the only type of point you can store is a Rapid point.

Measuring Continuous Topo Points

Continuous topo points are stored automatically and continuously after a preset time and/or distance, and once the required precisions are reached.

In a real-time survey, the Trimble Survey Controller software can measure a line of continuous *offset* points at the same time as a line of continuous topo points.

To measure a line of continuous topo points:

1. From the main menu, select *Survey / Continuous topo*.
2. In the *Type* field, select *Fixed distance continuous*, *Fixed time continuous*, or *Time & distance continuous*.

Note – For a postprocessed survey, you can only use the Fixed time continuous method. The time interval is set by default to the same value as the logging interval.

3. Enter a value in the *Antenna height* field and make sure that the setting in the *Measured to* field is set appropriately.
4. Enter a value in the *Horizontal distance* field and/or the *Time interval* field, depending on the method you are using.
5. Do one of the following:
 - If you are measuring *Fixed distance* or *Time & distance continuous* points, select *None* in the *Offset* field.
 - If you are measuring *Fixed distance* or *Time & distance continuous offset* points, select *One* or *Two* (the second line of offset points) in the *Offset* field.
6. Enter a value in the *Start point name* field (or enter a start point name for the center line when measuring offset points). This increments automatically.
7. If you are measuring an offset line, enter the offset distances and the start point name. To enter a left horizontal offset, enter a negative offset distance or use the **Left** or **Right** .
8. Tap to start recording data, and then move along the feature to be surveyed.

Note – To change the distance interval, time interval, or offset while measuring points, enter new values in the fields.

9. To stop measuring continuous points, tap .

Measuring an As-Staked Point

You can only measure an as-staked point when performing stakeout operations in a real-time GPS survey or a conventional survey.

In a GPS survey, a point is staked out then measured. For more information, see Chapter 17, GPS Stakeout.

Measuring a Laser Point

Use a laser rangefinder to measure a laser point. For more information, see Chapter 23, Laser Observations.

Measuring a Calibration Point

In a real-time survey, you measure calibration points. Generally, a point in the database has keyed-in grid coordinates and you measure it as a calibration point using GPS. When you store the calibration point, the Trimble Survey Controller software does one of the following, according to the *Auto calibrate* option that you selected in the survey style:

- If the *Auto calibrate* check box is selected, the software immediately performs an automatic calibration using all calibration points that have been surveyed.
- If the *Auto calibrate* check box is not selected, the point is added to the calibration and the *Site calibration* screen is displayed.

For more information, see Using GPS to Measure Calibration Points, page 279.

Note – In the *Site calibration* option in the survey style, calibration points are configured to be measured with the same settings as topo points or observed control points. However, with calibration points, the softkey lets you navigate to the next calibration point, and the *Auto calibrate* setting described above can be used.

Measuring a Check Point

In a GPS survey, measure a point twice. Give the second point the same name as the first point. If the duplicate point tolerances are set to zero, the Trimble Survey Controller software warns that the point is a duplicate when you try to store it. Select *Store as check* to store the second point as a check class point. For more information, see Duplicate Point Actions, page 212.

Next Free Point Name Search

In *Point name* fields there is a softkey that lets you search for the next available point name.

For example, if your job contains points numbered in the 1000s, 2000s and 3000s, and you want to find the next available point name after 1000:

1. In the *Point name* field, tap . The *Find next free point name* screen appears.
2. Enter the point name you want to start searching from (in this example, 1000) and tap .

The Trimble Survey Controller software searches for the next available point name after 1000 and inserts it in the *Point name* field.

Storing Points

How you record a point determines how it is stored in the Trimble Survey Controller software. Points are stored either as vectors or as positions. For example, RTK points and conventionally observed points are stored as vectors, while keyed-in points, real-time differential points, and postprocessed points are stored as positions.

From the main menu, select *Files / Review current job*. A point record contains information about the point such as the point name, the code, the method, the coordinates, or the GPS data file name. The *Method* field describes how the point was created.

The coordinates are expressed as WGS-84, local, or grid coordinates, depending on the setting in the *Coordinate view* field. To change a *Coordinate view* setting, do one of the following:

- Select *Configuration / Job / Units*
- Select *Files / Review current job*, access the point record, and tap **Options**.

Note – *Define a datum transformation and/or a projection if you want to display local or grid coordinates for a GPS point. Alternatively, calibrate the job.*

Each point record uses the antenna height given in the previous antenna height record. From this, the Trimble Survey Controller software generates a ground height (elevation) for the point.

Table 16.2 shows how the point is stored in the *Stored as* field.

Table 16.2 Point storage

Value	What the point is stored as
Grid	Grid coordinates
Local	Local geodetic coordinates
WGS-84	WGS-84 geodetic coordinates
ECEF	WGS-84 Earth-Centered-Earth-Fixed X, Y, Z coordinates

Table 16.2 Point storage (Continued)

Value	What the point is stored as
ECEF deltas	WGS-84 Earth-Centered-Earth-Fixed X, Y, Z vector
Polar	Azimuth, horizontal distance, and vertical distance. This is a vector.
HA VA SD	A horizontal circle reading, vertical circle reading (a zenith angle), and slope distance. This is a vector.
HA VA SD (raw)	A horizontal circle reading, vertical circle reading (a zenith angle), and slope distance with no corrections applied. This is a vector.
Mag.Az VA SD	A magnetic azimuth, vertical (zenith) angle, and slope distance vector.
MHA MVA MSD	A meaned horizontal angle from the backsight, meaned vertical angle (a zenith angle), and meaned slope distance. This is a vector.
MHA MHD MVD	A meaned horizontal angle from the backsight, meaned horizontal distance, and meaned vertical distance. This is a vector.

Read the *Stored as* field in conjunction with the *Method* field.

Note – *Points stored as vectors are updated if the calibration or coordinate system of the job changes, or the antenna height of one of the source points is changed. Points stored as WGS-84 coordinates (for example, an offset point calculated using the From a baseline method) are not updated.*

For GPS points, Quality Control (QC) records are stored at the end of the point record.

Point Classification

When points are stored they have either one or two classifications:

- Points that have been measured using GPS have an observation class and a search class.
- Points that have been keyed in, computed, or measured with a conventional instrument or laser rangefinder have only a search class.

Observation class

For real-time surveys, the observation class is L1 Fixed, L1 Float, WA Fixed, WA Float, or L1 Code, and precisions are recorded. For postprocessed surveys, the observation class is autonomous and no precisions are recorded.

Table 16.3 lists the observation classes and resulting solutions.

Table 16.3 Observation classes

Observation class	Result
L1 Fixed	An L1 fixed real-time kinematic solution.
L1 Float	An L1 float real-time kinematic solution.
L1 Code	An L1 code real-time differential solution.
Autonomous	A postprocessed solution.
WAAS	A position that has been differentially corrected using WAAS signals.
WA Fixed	A fixed solution using Wide Area processing.
WA Float	A float solution using Wide Area processing.

Search class

A search class is applied to a point when it is measured, keyed in, or computed. The search class is used by the Trimble Survey Controller software when details of a point are required for stakeout or calculations (for example, for Cogo calculations). When you select a point name, the database is searched from the start down. The first search is for a control class point. If no point is found, the next search is for a normal class point, then an as-staked point, then a backsight class point. If still no point is found, the final search is for a check class point. Table 16.4 describes the different search classes.

Table 16.4 Search classes

Search class	Description
Control	The highest order of search class. A control class point can only be overwritten by another control class point. Key in or upload control points. Points that are adjusted in a traverse are stored as control points.
Normal	Most points are usually measured as normal class. A normal class point can only be overwritten by another normal class point later in the database, or by a control class point.
As-staked	If a point was staked out and then measured, it has an as-staked classification.
Backsight	If a point was observed as a backsight or a resection target in a conventional survey, it has a backsight classification.

Table 16.4 Search classes (Continued)

Search class	Description
Check	<p>Check class is the lowest order of search class that will be found by the Trimble Survey Controller software search rules.</p> <p>Check class points can be overwritten by any class of point except deleted points.</p> <p>A check point can only be measured; it cannot be keyed in.</p>
Deleted	<p>When points are deleted in the Trimble Survey Controller software, the original class is given the prefix Deleted. Deleted class points are not displayed in lists, used in calculations, or found by database searches.</p>

Note – Measured points have a search class of normal or lower.

For more information, see Appendix B, Database Search Rules.

GPS Stakeout

In this chapter:

- Introduction
- General procedure
- Fine and coarse modes
- Using the graphical display to navigate
- Points
- Lines
- Arcs
- Digital Terrain Models

Introduction

In a real-time survey, you can stake out points, lines, arcs and digital terrain models (DTMs). Postprocessed survey techniques are not used for stakeout.

To stake out a road, see Chapter 6, Roading.



Warning – Do not stake out points, and then change the coordinate system or perform a calibration. If you do, these points will be inconsistent with the new coordinate system and with points staked out after the change.

General Procedure

When you stake out a point, set up the base receiver as usual and use the rover receiver to locate and stake out points.

Note – To stake out Grid coordinates, define a projection and datum transformation. Trimble strongly recommends that you perform a full site calibration before staking out any points.

To stake out a point:

1. Change the stakeout settings if necessary. For more information, see page 209.
2. Define the point/line/arc/DTM. To do this, use one of the following methods:
 - Key in data.
 - Transfer a file from a PC.
 - Calculate coordinates using one of the Cogo functions.
3. Use one of the following methods to select a point:
 - From the map, select the feature to be staked out—points, lines, or arcs.

- From the main menu, choose *Survey / Stakeout*. Then select the feature to be staked out.
- 4. Initialize the survey.
- 5. Navigate to the point.
- 6. Stake out the point.
- 7. Measure the as-staked point (this step is optional).
- 8. Repeat steps 5 and 6 until all points are staked out.
- 9. End the survey.

Fine and Coarse Modes

Choose either the fine or coarse mode when navigating to a point. Use the **►Fine** or **►Coarse** softkeys in the *Stakeout* graphical display to change from one to the other:

- The **►Fine** softkey appears when the Trimble Survey Controller software is in coarse mode. Tap it to go into fine mode.
The display updates at a rate of one position per second, and the precision of the position is higher.
- The **►Coarse** softkey appears when the Trimble Survey Controller software is in fine mode. Tap it to go into coarse mode.
The display updates at a rate of five positions per second, and the precision of the position is lower.

Note – When you tap **►Fine** the graphical display screen zooms in and magnifies the display by the zoom factor specified in the survey style.

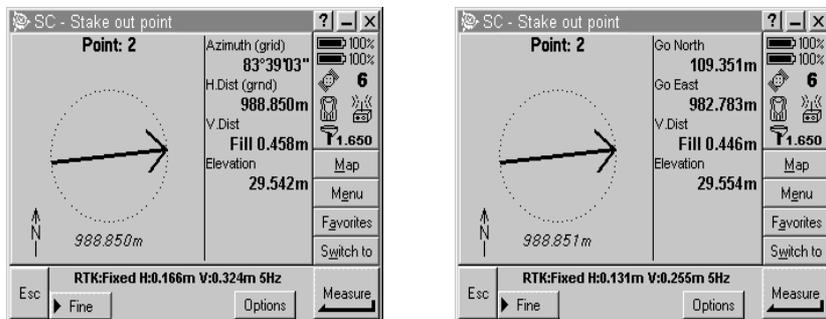
Use the coarse mode until close to the point, then switch to fine mode.

Using the Graphical Display to Navigate

When staking out a point, line, arc, or road, use either the text on the right of the screen or the graphical display on the left to navigate to the point. This section describes how to use the graphical display.

The following screens show typical graphical displays. Each shows the compass arrow, but the text display configuration differs.

- In the left screen, the *Display grid deltas* check box in the Stakeout *Options* screen is not selected.
- In the right screen, the *Display grid deltas* check box is selected.

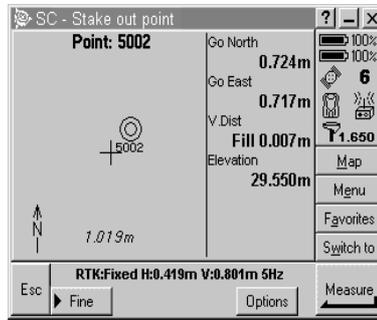


To navigate using the graphical display:

1. Start moving towards the point, holding the data collector in front of you and using the arrow as a guide. As you walk forward, the arrow indicates the direction of the point to be staked out, and the top of the screen.

Note – The direction arrow only works correctly when you are moving. Always move **forward** towards the point.

- About 10 feet (3 meters) from the point, the arrow disappears and the point is shown as a bull's-eye symbol. Your current position appears as a cross, as shown in the following screen:



When the screen display changes from an arrow to a bull's-eye and a cross, the orientation of the display is fixed.

- When you get closer to the point, tap **Fine** to go into fine mode. The display zooms in and updates at a rate of one position per second. For more information, see Fine and Coarse Modes, page 309.
- Move towards the point until the cross covers the bull's-eye in the graphical display. Check the precisions and mark the point.

If you are not sure how to use the graphical display, use the text side of the display to locate the point.

Points

To stake out a point:

- From the map, select the point(s) to be staked out. Tap **Stakeout**.
If you have selected more than one point from the map for staking out, the *Stake out points* screen appears. Go to the next step. If you have selected one point from the map, go to step 4.
- The *Stake out points* screen lists all points selected for stakeout. To add more points to the list, do one of the following:

- Tap and select the required points from the map. Tap to return to the *Stake out points* screen.
- Tap to select points in the Trimble Survey Controller software database or in a comma delimited (.csv, or Comma Separated Values) file. Choose the method by which points are to be selected.

Use the *Select from list* option to select from a list of all points in the Trimble Survey Controller database. Use the *Select from file* option to select points in a comma delimited file.

Note – *If two points have the same name, only the point with the higher class—or the first point in a .csv file—is displayed.*

3. To select a point for stakeout, highlight the point from the *Stake out points* screen and tap . The *Stake out point* screen appears.
4. In the *Stake* field, select one of the following methods for staking out the point:
 - *To the point* – stake out the point with directions from your current position.
 - *From fixed point* – stake out the point with cross-track information and directions from another point. Enter a point name in the *From point* field. Select from a list, key in, or measure this value.
 - *From start position* – stake out the point with cross-track information and directions from the current position when you start to navigate.
 - *From last point staked* – stake out the point with cross-track information and directions from the last point that was staked out and measured. The **staked** point is used, not the design point.

To stake out from the current position, access the *From point* field and tap .

***Note** – The cross-track function creates a line between the point to be staked out and one of the following: a fixed point, the start position, or the last point staked. The Trimble Survey Controller software displays this line, and an extra field in the graphical stakeout screen gives the offset to the line. The extra field is Go left or Go right.*

5. Enter a value in the *Antenna height* field and make sure the setting in the *Measured to* field is set appropriately.
6. Tap . The stakeout graphical display screen appears.
7. Navigate to the point, as follows:
 - a. Use the graphical display or the text display to navigate to the point. For more information, see *Using the Graphical Display to Navigate*, page 310.
 - b. Closer to the point, tap to go into Fine mode.
 - c. In the graphical display, when the cross covers the bull's-eye, check the precisions and mark the point.
 - d. Do one of the following:

To record the as-staked point, tap . The Trimble Survey Controller software measures the point.

If you do not want to record the as-staked point, tap to return to the list and stake out more points.

Lines

To stake out a line:

1. From the map, select the line to be staked out. Tap **Stakeout**. The *Stake out line* screen appears.
2. The selected line is displayed in the *Line name* field. To select another line in the *Line name* field, use one of the following methods:
 - Tap  to display a list of lines selected from the map. Tap the required line to select it. If necessary, reselect the line from the map.
 - Tap **List** to display a list of lines stored in the Trimble Survey Controller software database. Tap the required line to select it.
 - Tap **Key in** and define the line to be staked out.
3. Enter a value in the *Antenna height* field.
4. Choose a method in the *Stake* field. For more information, see *Choosing a Method (Lines)*, page 316. Enter the required information in the fields that appear.
5. Tap **Start**. The stakeout graphical display screen appears, displaying a compass arrow and some text. The values in the following fields are appropriate to the stakeout method used:
 - *Azimuth* – the azimuth to the line or station on the line.
 - *Go South/North* – the horizontal distance, in the north/south direction, to the line or station on the line
 - *Go East/West* – the horizontal distance, in the east/west direction, to the line or station on the line
 - *H. Dist* – the horizontal distance between the present position and the point on the line to be staked out
 - *V. Dist (cut/fill)* – the vertical distance between the present position and the point on the line to be staked out

-
- *Stationing* – the station/chainage of the present position
 - Δ *Station* – the difference in the stationing between the present position and the station to be staked out. A positive value means that the station is towards the beginning of the line. A negative value means that the station is towards the end of the line.
 - *Offset (left/right)* – the offset of the present position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.
 - *Grade to line*—the grade of the slope between the present position and the closest point on the line
6. Navigate to the point, as follows:
- a. Use the graphical display or the text display to navigate to the point. For more information, see Using the Graphical Display to Navigate, page 310.
 - b. Closer to the point, tap to go into fine mode.
 - c. In the graphical display, when the cross covers the bull's-eye, check the precisions and mark the point.
 - d. Tap to record the as-staked point. The Trimble Survey Controller software measures the point.
 - e. Tap to return to the *Stake out line* screen, and tap or to select the next station on the line. Stake out the point as described above.

Choosing a Method (Lines)

The following sections describe each method of staking out lines.

To the line

To use this method:

1. Select *Stake / To the line*.
2. As shown in the following diagram, stake out points on a line, starting at the closest point (1) from your current position (2). If your current position is beyond the end of the line, the Trimble Survey Controller software directs you to the closest point along the extension of the line.

Figure 17.1 shows the screen that appears and a graphical representation of this method.

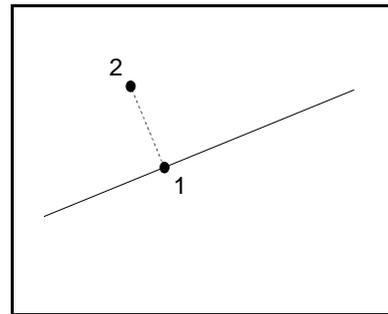
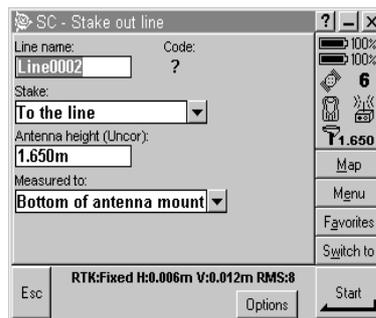


Figure 17.1 To the line

Station on the line

To use this method:

1. Select *Stake / Station on the line*.
2. As shown in the following diagram, stake out stations (1) on a line with a defined station increment (2).

Figure 17.2 shows the screen that appears and a graphical representation of this method.

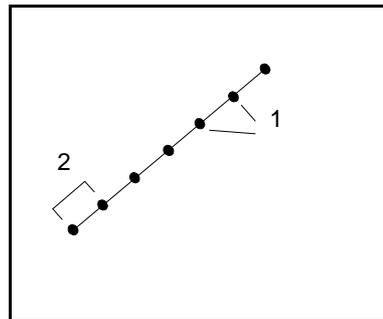
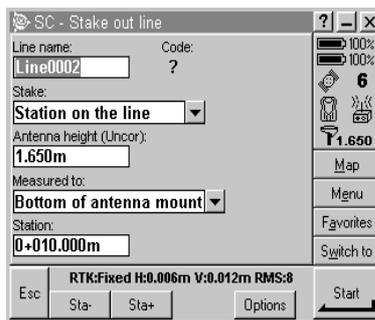


Figure 17.2 Station on the line

Station/offset from line

To use this method:

1. Select *Stake / Station/Offset from line*.
2. As shown in the following diagram, stake out points (1) that are perpendicular to stations (3) on a defined line (2) and offset to the right or left by a set distance (4).

Figure 17.3 shows the screen that appears and a graphical representation of this method.

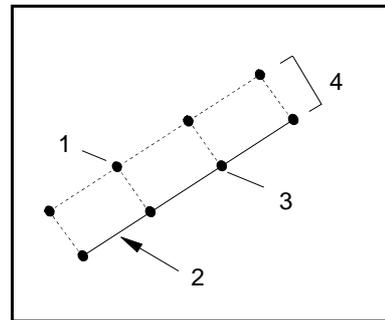
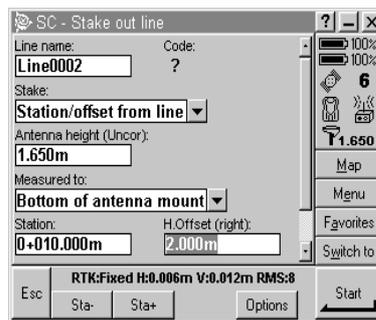


Figure 17.3 Station/offset from line

Slope from line

To use this method:

1. Select *Stake / Slope from line*.
2. As shown in the following diagram, stake out a surface (2) at defined grades (3) from the defined line (cross-section = 1). Different slopes can be defined on the left and the right of the line. At any point offset from the line, the value for cut (4) or fill (5) is displayed.

Figure 17.4 shows the screen that appears and a graphical representation of this method.

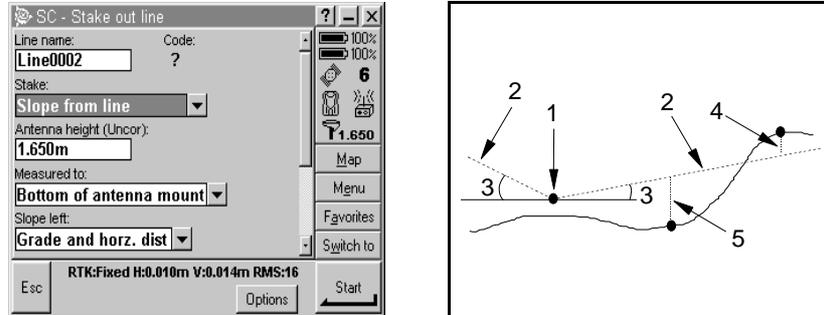


Figure 17.4 Slope from line

The left side of the line is the side on your left as you look along the line in the direction of increasing stationing.

Use the *Slope left* field and the *Slope right* field to define the type of grade in one of the following ways:

- horizontal and vertical distance
- grade and slope distance
- grade and horizontal distance

You can also enter a value in the *Grade* field (this is optional).

Arcs

Note – The Trimble Survey Controller software supports the design and stakeout of circular arcs only. Use the road stakeout function to stake out other arc types.

To stake out an arc:

1. From the map, select the arc to be staked out. Tap . The *Stake out arc* screen appears.
2. The selected arc is displayed in the *Arc name* field. To select another arc in the *Arc name* field, use one of the following methods:
 - Tap to display a list of arcs selected from the map. Tap the required arc to select it. If necessary, reselect the arc from the map.
 - Tap to display a list of arc stored in the Trimble Survey Controller software database. Tap the required arc to select it.
 - Tap and define the arc to be staked out.
3. Enter a value in the *Antenna height* field.
4. Choose an option in the *Stake* field. For more information, see *Choosing a Method (Arcs)*, page 322. Enter the required information in the fields that appear.
5. Tap . The stakeout graphical display screen appears, displaying a compass arrow and some text. The values in the following fields are appropriate to the stakeout method used:
 - *Azimuth*
 - *Go South/North* – the horizontal distance, in the north/south direction, to the arc or station on the arc
 - *Go East/West* – the horizontal distance, in the east/west direction, to the arc or station on the arc

-
- *H. Dist* – the horizontal distance between the present position and the point on the arc to be staked out
 - *V. Dist (cut/fill)* – the vertical distance between the present position and the point on the arc to be staked out
 - *Stationing*—the station/chainage of the present position
 - Δ *Station* – the difference in stationing between the present position and the station to be staked out. A positive value means that the station is towards the beginning of the arc. A negative value means that the station is towards the end of the arc.
 - *Offset (left/right)* – the offset of the present position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.
 - *Grade to arc* – the grade of the slope between the present position and the closest point on the arc
6. Navigate to the point, as follows:
- a. Use the graphical display, or the text display, to navigate to the point. For more information, see Using the Graphical Display to Navigate, page 310.
 - b. Closer to the point, tap to go into fine mode.
 - c. In the graphical display, when the cross covers the bull's-eye, check the precisions and mark the point.
 - d. To record the as-staked point, tap . The Trimble Survey Controller software measures the point.
 - e. Tap to return to the *Stake out arc* screen. Then tap or to select the next station on the arc.

Choosing a Method (Arcs)

The following sections describe each method for staking out arcs.

To the arc

To use this method:

1. Select *Stake / To the arc*.
2. As shown in the following diagram, stake out points on a arc, starting at the closest point (1) to your current position (2). If your current position is beyond the end of the arc, the Trimble Survey Controller software directs you to the closest point along the extension of the arc.

Figure 17.5 shows the screen that appears and a graphical representation of this method.

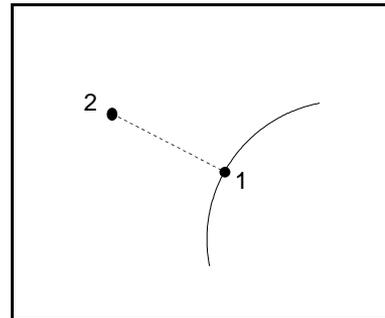
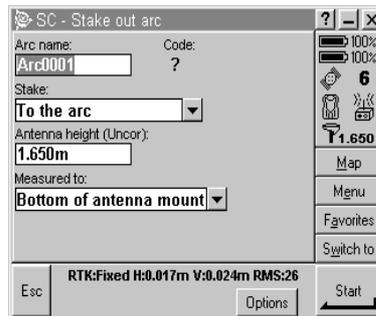


Figure 17.5 To the arc

Station on the arc

To use this method:

1. Select *Stake / Station on the arc*.
2. As shown in the following diagram, stake out stations (1) on an arc with a defined station increment (2).

Figure 17.6 shows the screen that appears and a graphical representation of this method.

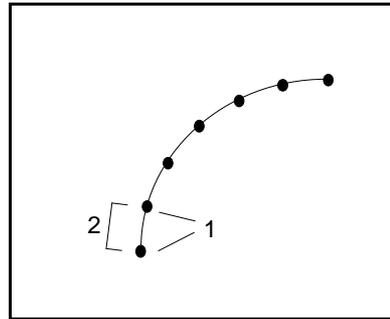
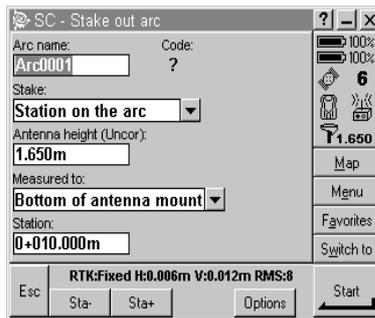


Figure 17.6 Station on the arc

Station/offset from arc

To use this method:

1. Select *Stake / Station/Offset from arc*.
2. As shown in the following diagram, stake out points (1) perpendicular to stations (3) on the defined arc (2) and offset to the right or left by a certain distance (4).

Figure 17.7 shows the screen that appears and a graphical representation of this method.

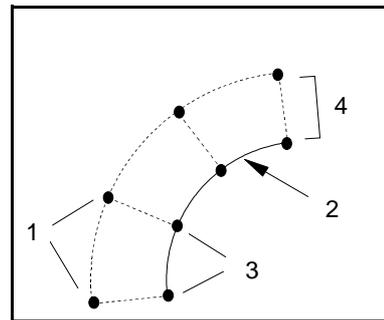
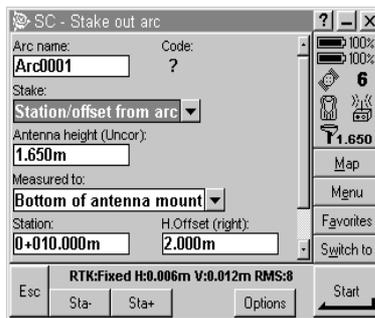


Figure 17.7 Station/offset from arc

Slope from arc

To use this method:

1. Select *Stake / Slope from arc*.
2. As shown in the following diagram, stake out points at any position on a surface made up of sloping lines (2), at defined grades (3), perpendicular to the defined arc (cross-section = (1)). Different slopes can be defined on the left and the right of the arc. At any point offset from the arc the value for cut (4) or fill (5) is displayed.

Figure 17.8 shows the screen that appears and a graphical representation of this method.

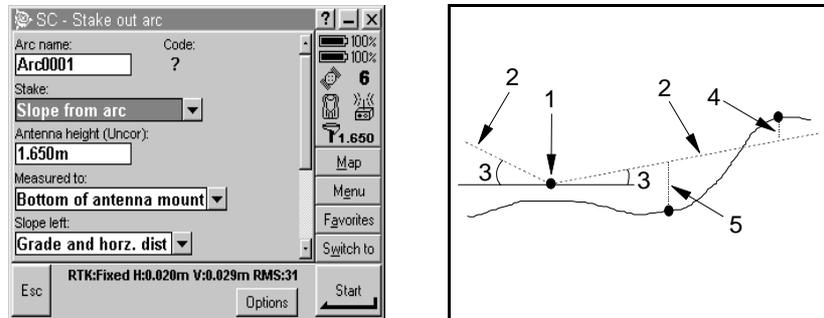


Figure 17.8 Slope from arc

The left side of the arc is on your left as you look along the arc in the direction of increasing stationing.

Use the *Slope left* field and the *Slope right* field to define the type of grade in one of the following ways:

- horizontal and vertical distance
- grade and slope distance
- grade and horizontal distance

You can also enter a value in the *Grade* field (this is optional).

Intersect point of arc

To use this method:

1. Select *Stake / Intersect point of arc*.
2. As shown in the following diagram, stake out the intersection point (1) of a defined arc (2).

Figure 17.9 shows the screen that appears and a graphical representation of this method.

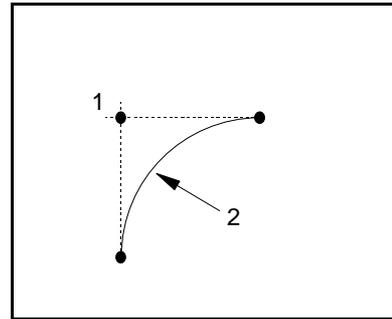
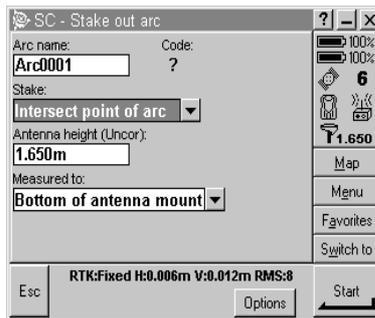


Figure 17.9 Intersect point of arc

Center point of arc

To use this method:

1. Select *Stake / Center point of arc*.
2. As shown in the following diagram, stake out the center point (1) of a defined arc (2).

Figure 17.10 shows the screen that appears and a graphical representation of this method.

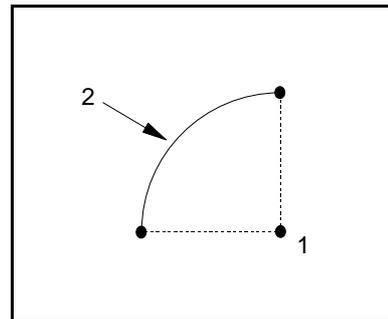
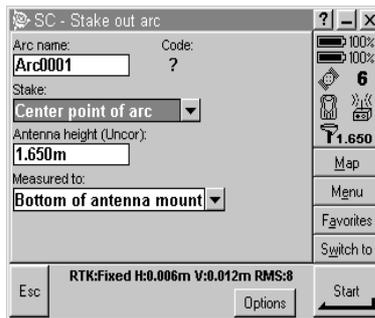


Figure 17.10 Center point of arc

Digital Terrain Models

To stake out a digital terrain model (DTM):

1. From the main menu, select *Survey*. Choose a real-time survey style, then select *Stakeout / DTMs*. The *Stake out DTM* screen appears.
2. In the *DTM* field, select the model to be staked out.
3. If necessary, enter a value in the *Vertical offset* field.
4. Enter a value in the *Antenna height* field.
5. Tap . The stakeout graphical display screen appears, displaying the coordinates of the current position and the vertical distance above (cut) or below (fill) the DTM.
6. Tap for the Trimble Survey Controller software to measure the point.
7. Tap to return to the *Stake out DTM* screen.

Conventional Instrument Survey Styles

In this chapter:

- Introduction
- Conventional survey styles
- Creating and editing a conventional survey style

Introduction

This chapter shows you how to create and configure a conventional survey style.

When you use the Trimble Survey Controller software for a conventional survey, choose a conventional survey style that is specific to the type of instrument used, and your measurement preferences.

Conventional Survey Styles

Use a survey style to change the configuration of the Trimble Survey Controller software quickly and easily for different types of survey. Each survey style contains a set of information specific to your equipment and preferences. The information is stored as a pattern or template that you can call up and re-use when necessary. To survey using the Trimble Survey Controller software and a conventional instrument, select a conventional survey style.

A conventional survey style defines the parameters for configuring and communicating with your instruments and for measuring and storing points.

The Trimble Survey Controller software provides default conventional, robotic, and servo survey styles for use with Trimble conventional instruments. To use any other type of instrument, modify these survey styles or create a new conventional survey style.

Creating and Editing a Conventional Survey Style

To create a conventional survey style:

1. From the main menu, choose *Configuration / Survey styles*. The *Survey Styles* screen appears. Tap .
2. Enter a name in the *Style name* field.
3. In the *Style type* field, select *Conventional*. Tap to accept the screen. A screen with options relevant to the chosen style type appears.
4. Select each item in turn and specify your equipment and preferences in the screens that appear. For information about each menu item, see the following sections.

To edit a conventional survey style:

1. From the main menu, select *Configuration / Survey Styles*. The list of survey styles appears.
2. Highlight the name of the survey style to be edited and tap .
3. Change each option as required. For information about each menu item, see the following sections.

For more information on configuring a conventional survey style and your conventional instrument, see Appendix C, Conventional Instrument Settings.

Select *Instrument* to specify the type of instrument used and its communication parameters.

Instrument Type

The Trimble Survey Controller software interfaces with different brands of conventional instrument. Access the *Manufacturer* and *Model* (optional) fields to display a list of these names and then select the instrument you are using. The default communications parameters for the instrument appear. Change them if necessary. There is also a manual entry mode that lets you key in observations.

Communication Settings

Use the *Baud rate* field to configure the Trimble Survey Controller baud rate to match that of the conventional instrument.

Use the *Parity* field to configure the Trimble Survey Controller parity to match that of the conventional instrument.

When you change the instrument type, the baud rate and parity settings automatically change to the default settings for the selected instrument.

HA VA status rate

Use the *HA VA status rate* field to set how often the Trimble Survey Controller software updates the horizontal and vertical angle display in the status line with information from the conventional instrument.

Note – *Some instruments beep when communicating with the Trimble Survey Controller software. You can turn off the beep in the instrument or set the HA VA status rate to Never.*

EDM Precision

The *EDM precision* field appears if the instrument type specified has more than one measuring mode that can be set by the Trimble Survey Controller software. Use it to specify how the EDM measures distances. The options vary according to the option that you selected in the *Type* field. Select the *Instr. default* option to always use the setting on the instrument.

Set backsight

The *Set backsight* field appears if you can set the horizontal circle reading on the instrument when the backsight is observed. The options are *No*, *Zero*, and *Azimuth*. If you select the *Azimuth* option, when you observe the backsight the horizontal circle reading is set to the computed azimuth between the instrument point and the backsight point.

Stakeout auto turn

When the instrument type is a servo or robotic instrument, the *Stakeout auto turn* check box and the *Servo options* field appears. Select the check box if you want the Trimble Survey Controller software to operate the servos automatically during stakeout when you are measuring a known (coordinated) point.

Use the *Servo options* field specify which servos are used—choose from *HA only*, or *HA & VA*.

Instrument precisions

Use the *Instrument precision* fields to record the precisions of the instrument. Do one of the following:

- Leave them as null.
- Enter the manufacturer's values.
- Enter your own values based on your observing techniques.

If you enter values, they are used by the Trimble Geomatics Office software to compute the standard error statistics for an observation. If you leave the fields as null, the Trimble Geomatics Office default values are used to compute the standard error statistics.

Target

Select *Target* to enter information about the target in use.

Use the *Prism constant* field to specify the distance offset for each prism. When the prism constant is to be subtracted from measured distances, enter a negative value.

For some instruments, the Trimble Survey Controller software checks to see if a prism constant has been applied by the instrument and the Trimble Survey Controller software. When you select *Station setup*, messages are displayed in the status line showing what has or has not been checked.

If the Trimble Survey Controller software cannot check the setting on the conventional instrument, do one of the following:

- If there is a prism constant set on the instrument, make sure that the prism constant in the Trimble Survey Controller software is set to 0.000.
- If there is a prism constant set in the Trimble Survey Controller software, make sure that the prism constant in the instrument is set to 0.000.

Use the *Height* field to specify a target height. This is the distance from the point you are measuring to the center of the target.

Laser Rangefinder

Select *Laser Rangefinder* to set the parameters for using a laser rangefinder with a conventional instrument. For more information about configuring a laser, see Chapter 23, Laser Observations.

Topo point

Select *Topo point* to set the parameters for observing topographic points.

Use the *Measure display* field to define how the observations are displayed on the TSCe data collector. See Table 18.1.

Table 18.1 Measure display options

Option	Corrections applied	Description
HA VA SD (raw)	None	Observation as seen on the conventional instrument display
HA VA SD	Prism constant	Raw observation corrected for prism constant
HA HD VD	Prism constant Pressure and temperature Instrument height and Target height Curvature and refraction	HA and HD from Station ground point to Target ground point and the height difference (VD) between these points
Az VA SD	Prism constant Pressure and temperature Orientation Curvature and refraction	Raw observation corrected for prism constant, orientation, and atmospheric effects.
Az HD VD	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction	Same as HA HD VD but with backsight orientation applied to the HA
Δ Grid	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction Polar to rectangular	Trigonometrical calculation of the Δ NEE relative to the instrument The same information as AZ HD VD but presented as rectangular coordinates

Table 18.1 Measure display options (Continued)

Option	Corrections applied	Description
Grid	Prism constant Pressure and temperature Orientation Instrument height and Target height Curvature and refraction Polar to rectangular conversion Full coordinate transformation	Reduced grid coordinates

Use the *Auto point step size* field to set the increment size for automatic point numbering. The default is 1, but you can use larger step sizes and negative steps.

Select the *View before storage* check box to view observations before they are stored.

Rounds

Select *Round* to specify the settings for measuring multiple sets (rounds) of observations.

Use the *Number of rounds* field to specify the number of rounds of observations that the Trimble Survey Controller software prompts for.

Use the *Observation order* field to specify the order in which the Trimble Survey Controller software prompts for observations in the rounds survey.

Select *Measure distance on face 2* to measure the distances on face 2 observations.

Corrections

Select *Corrections* to set the corrections associated with conventional observations.



Warning – Check the conventional instrument to make sure that corrections are not being applied by both the instrument and the Trimble Survey Controller software.

Use the *PPM* field to specify a parts per million correction. This correction applies a scale factor to the electronic distance measurement based on environmental conditions. Manually key in the PPM correction, or enter the pressure and temperature of the surrounding environment and let the Trimble Survey Controller software compute it.

Use the *Curvature and refraction* field to specify the index of refraction value. This is used to compute the curvature and refraction correction that is applied to vertical angle observations. See Table 18.2.

Table 18.2 Curvature and refraction options

Option	Description
0.142	for use during the day
0.2	for use at night
None	no correction applied

For some instruments, the Trimble Survey Controller software automatically checks to see if various corrections (PPM, prism constant, and curvature and refraction) are being applied correctly. If it finds that the corrections are being applied twice, a warning message appears.

Note – *If you intend to perform a network adjustment in the Trimble Geomatics Office software using data from a conventional survey, make sure that you enter a pressure, temperature and, curvature and refraction correction.*

Stakeout

To configure the as-staked point details:

1. Select the *View before storage* check box. This lets you view the difference between a design point and the measured as-staked point before storing the point.
2. Enter a value in the *Horizontal tolerance* field. The Trimble Survey Controller software displays the deltas if this tolerance is exceeded. The default is 0.000 (deltas always displayed).
3. Specify the name of the as-staked point to be the next auto point name or a point name that is equivalent to its design name.
4. Specify the code of the as-staked point to be the design point name or the design point code.
5. To display the as-staked deltas as grid (Northing, Easting, Elevation) values, select the *Display grid deltas* check box.

The stakeout graphical display screen displays directions using the conventional instrument as a reference point.

To configure the display:

1. Choose a setting in the *Deltas* field. The options are:
 - Angle and distance – navigate to a point using angle and distance
 - Distances – navigate to a point using distances only

For a comparison of these options, see the stakeout screens shown on page 382.

2. Use the *Distance tolerance* field to specify the allowable error in distance. If the target is within this distance from the point, the graphical stakeout display indicates that the distance(s) is correct.
3. Use the *Angle tolerance* field to specify the allowable error in angle. If the conventional instrument is turned away from the point by less than this angle, the graphical stakeout display indicates that the angle is correct.

4. If you define a DTM and select the *Display cut/fill to DTM* check box, the graphical display screen displays cut or fill relative to that DTM. Use the *DTM* field to specify the name of the DTM to be used.

Duplicate point actions

In a conventional survey, you can set the tolerances for a duplicate point warning. If you are measuring a point using the *Angles and distance*, *H. Angle offset* or *Single dist. offset* method, you can specify the maximum horizontal and vertical distance that the new point can be from the existing point. Do one of the following:

- If you are measuring a point using the *Angles only* or *H. angle only* method, you can specify the maximum horizontal and vertical angle that the new observation can be from the existing observation.
- If you are measuring a coordinated point, the Trimble Survey Controller software will compare the observed angle with the computed angle between the instrument point and the observed point.
- If you are measuring a point that is not coordinated, the Trimble Survey Controller software will compare face 1 observations with the first face 1 observation.

When you try to store a new point, and the duplicate point is outside the tolerance you set, a duplicate point warning appears.

For more information, see Duplicate Point Actions, page 212.

Note – *In a conventional survey, when you enter a point name that already exists, the message Point already exists does not appear. This is because you may want to regularly measure points on both faces.*

When you use a conventional instrument to measure points on two faces, the Trimble Survey Controller software behaves according to the settings in the *Duplicate point actions* screen. For example:

If you make a face 1 observation to a point and then store a face 2 observation to the same point (with the same point name), the Trimble Survey Controller software performs a duplicate **observation** tolerance check between the two observations, based on the *F1/F2 observation tolerance* settings:

- If the face 1 and face 2 observations are within tolerance, they are averaged. A matched pair record is stored immediately after the face 2 observation. Furthermore, a mean turned angle record is stored after the matched pair. For more information about matched pairs and mean turned angles see, *Measuring a Point in Two Faces*, page 364.
- If the face 1 and face 2 observations are out of tolerance, the *Observation: Out of tolerance* screen appears. The options are:
 - Discard – discard the observation without storing.
 - Rename – rename to a different point name.
 - Store as check – store with a classification of Check.
 - Store another – store the observation and the matched pair.
 - Store and reorient – (This option only appears if you are observing a backsight point.) Store another observation that will provide a new orientation for subsequent points measured in the current station setup. Previous observations are not changed. Use this if you are doing multiple rounds of observations.

Note – *If the target height changed between the face 1 and face 2 observations, the Trimble Survey Controller software reduces the face 1 and face 2 observations to HA HD VD, and produces a matched pair that is the mean HA HD VD.*

When you make the next observation to the same point, the Trimble Survey Controller software performs a duplicate point tolerance check using the best point in the database and the point just measured:

- If it is within tolerance, the new observation is stored.
- If it is out of tolerance, the *Duplicate point: Out of tolerance* screen appears.

For more information, see, Duplicate point: Out of tolerance screen, page 212.

Traverse options

Use these options to specify how a traverse calculation is adjusted. See Table 18.3.

Table 18.3 Traverse adjustment options

Field	Option	What it does
Adjustment method	Compass	Adjusts the traverse by distributing the errors in proportion to the distance between traverse points
	Transit	Adjusts the traverse by distributing the errors in proportion to the northing and easting ordinates of the traverse points
Error distribution		
Angular	Proportional to distance	Distributes the angular error among the angles in the traverse based on the sum of the inverses of the distances between traverse points
	Equal proportions	Distributes the angular error evenly among the angles in the traverse
	None	Does not distribute the angular error
Elevation	Proportional to distance	Distributes the elevation error in proportion to the distance between traverse points
	Equal proportions	Distributes the elevation error evenly among the traverse points
	None	Does not distribute the elevation error

Note – The Compass option is the same as the Bowditch method of adjustment.

For information about calculating and adjusting a traverse, see Traverses, page 177.

Starting a Conventional Survey

In this chapter:

- Introduction
- Connecting to a conventional instrument
- Station setup
- Ending a conventional survey

Introduction

This chapter describes how to start a survey with a conventional instrument. It shows you how to:

- set up the equipment
- perform a station setup

Connecting to a Conventional Instrument

This section shows you how to assemble the equipment to do a survey with a conventional instrument.

To assemble the equipment:

1. Turn on the TSCe data collector.
2. From the main menu, select *Survey*.
3. Select the appropriate survey style.
4. Connect the TSCe data collector to the instrument.
5. Turn on the conventional instrument.
6. Perform a Station Setup. For more information, see, page 345.

Before starting a survey, find the settings for each model of instrument and make sure that they are compatible with the Trimble Survey Controller software. For more information, see Appendix C, Conventional Instrument Settings. Alternatively, contact your local Trimble dealer.

If you are operating a robotic instrument remotely, make sure the TSCe data collector is connected to the remote end (target) and that the instrument is configured for remote operation.

Station Setup

Before you start work in the field, make sure that the conventional instrument is correctly configured in the survey style that you intend to use, and that the correct job is open.

If you intend to combine GPS observations and conventional measurements in the same job, make sure that you define an appropriate coordinate system for the job. For more information, see *Choosing a Coordinate System for a Conventional Survey*, page 39.

Then set up the instrument on a tripod over a point and connect it to the TSCe data collector, as described in *Connecting to a Conventional Instrument*, page 344.

Before measuring points, rounds of observations, or staking out, perform a station setup on the TSCe data collector.

To perform a station setup:

1. From the main menu, select *Survey*. Choose the required survey style from the list and tap .
2. Select *Station setup*.

For some instruments, the Trimble Survey Controller software automatically checks to see if various corrections (PPM, prism constant, and curvature and refraction) are being applied correctly. When you select *Station setup*, messages showing what has or has not been checked are displayed in the status line. If the Trimble Survey Controller software finds that the corrections are being applied twice, a warning message appears.

3. Follow the instructions in one of the following sections, depending on the information available. This could be:
 - known coordinates for both the instrument point and the backsight point
 - known coordinates for the instrument point, unknown coordinates for the backsight point

- unknown instrument point coordinates, several known points surrounding the instrument point (resection)
- unknown instrument point coordinates (to be provided later), no known points to use as a backsight

Note – If you are using a coordinate system and zone from the Trimble Survey Controller software library, make sure that you use valid coordinates for that zone.

Known Coordinates for Both the Instrument Point and the Backsight Point

If the instrument point and the backsight point are already stored in the Trimble Survey Controller database:

1. In the *Instrument point name* field, enter the station point name.
2. Enter a value in the *Instrument height* field.

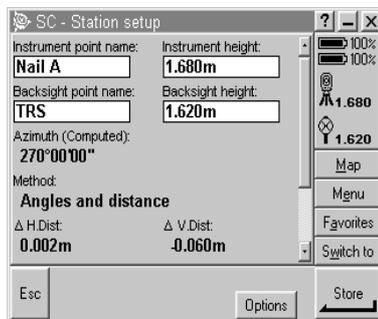
Note – For a 2D or planimetric survey, leave the *Instrument height* field set to null (?). No elevations are calculated. A project height must be defined before the Trimble Survey Controller can coordinate 2D observations.

3. Enter a value in the *Backsight point name* field.

The Trimble Survey Controller software calculates the azimuth and inserts it in the *Azimuth* field, changing the field name to *Azimuth (Computed)*.

4. In the *Backsight height* field, enter the height of the backsight target.
5. Choose an option in the *Method* field. The options are:
 - Angles and distance – measure horizontal and vertical angles and slope distance
 - Angles only – measure horizontal and vertical angles
 - H. Angle only – measure horizontal angle only
6. Sight the center of the backsight target and tap **Measure**.

The horizontal and vertical distance deltas are the differences between the calculated position and the observed position of the backsight, as shown in the following screen:



7. Tap **Store** to accept the station setup. Station setup is complete.

Known Coordinates for the Instrument Point, Unknown Coordinates for the Backsight Point

If the instrument point is already stored in the Trimble Survey Controller database and the backsight coordinates are unknown:

1. In the *Instrument point name* field, enter the station point name.
2. Enter a value in the *Instrument height* field.

Note – For a 2D or planimetric survey, leave the Instrument height field set to null (?). No elevations are calculated.

3. Enter a value in the *Backsight point name* field. Because the backsight point is not in the database, the Trimble Survey Controller software asks if you want to key in the point. Tap **Continue**.
4. In the *Backsight height* field, enter the height of the backsight target.
5. In the *Azimuth* field, enter the azimuth (bearing) from the instrument point to the backsight point.

The Trimble Survey Controller software uses this azimuth to calculate a coordinate for the backsight point. The *Azimuth* field name changes to *Azimuth (Keyed in)*.

Note – If you do not know the azimuth at this stage, you can edit the azimuth record later in Review, or you can measure the backsight point using GPS. The coordinates of any points measured from that station will then be computed.

6. Choose an option in the *Method* field. The options are:
 - Angles and distance – measure horizontal and vertical angles and slope distance
 - Angles only – measure horizontal and vertical angles. With this method, no coordinates are calculated for the backsight point. (No coordinates can be obtained if there is no distance.)
 - H. Angle only - measure horizontal angle only
7. Sight the center of the backsight target and tap **Measure**. The measurement information is displayed on the following screen but no deltas are displayed because there are no known coordinates for the backsight:

The screenshot shows the 'SC - Station setup' window. It contains the following fields and values:

Instrument point name: Nail A	Instrument height: 1.680m	100% 100%
Backsight point name: OIT II	Backsight height: 1.620m	1.680 1.620
Azimuth (Keyed in): 294°00'00"	Horizontal angle: 294°00'00"	Map Menu Favorites Switch to
Method: Angles only	Slope distance: ?	Esc Options Store
Vertical angle: 92°00'00"	HA:294°00'00" VA:92°00'00"	

8. Tap **Store** to accept the station setup. Station setup is complete.

Unknown Instrument Point Coordinates, Several Known Points Surrounding the Instrument Point (Resection)

Use a resection calculation to compute coordinates for the instrument point by making observations to known points during the station setup process.

Note – In a resection, only use points that can be viewed as grid coordinates. (The resection calculation is a grid calculation.)

A resection needs a minimum of the following:

- Three sets of angles
- Two observations with horizontal and vertical angles and slope distances

The Trimble Survey Controller software uses a least-squares algorithm to compute the resection. This uses all of the data collected and gives a statistically better result.

When doing a resection, make sure that the geometry of the observations will produce a stable result. In a two-point resection, the result can be unreliable if the angle between the instrument point and the two resection points is close to 180°. In a three-point resection, the result can be unreliable if the three points and the instrument point lie on a circle. For all resections, results are unreliable if the points you are observing are close together.

Table 19.1 shows the different types of resection provided by the Trimble Survey Controller software.

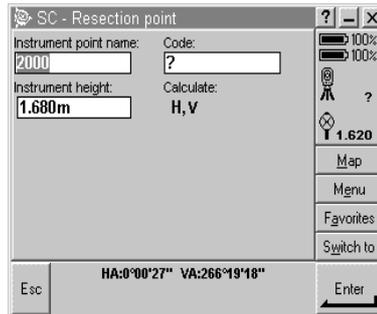
Table 19.1 Values computed by resection

Known coordinate values for instrument point	Values computed by resection
Northing, Easting, Elevation	Northing, Easting, Elevation
Northing, Easting	Elevation
Elevation	Northing, Easting
None	Northing, Easting, Elevation

To do a resection:

1. In the *Instrument point name* field, enter the station point name.

The Trimble Survey Controller software warns that the point is not in the database, and the **Key in**, **Resect**, and **Continue** softkeys appear. Tap **Resect**. The following screen appears:

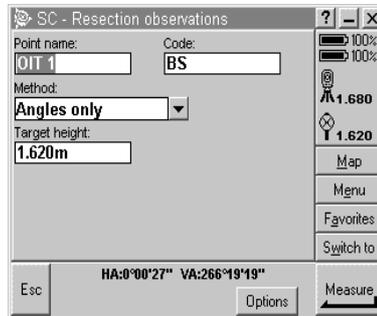


2. In the *Instrument height* field, do one of the following:
 - For a 2D resection, leave the field value as null (?).
 - For a 3D resection, enter a value.

If you entered a value in this field in the *Station Setup* screen, the Trimble Survey Controller software automatically transfers that value to this screen.

Note – *Once the resection is started you cannot enter a different instrument height.*

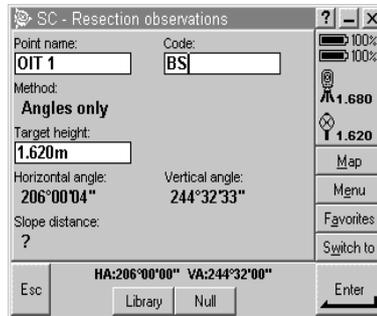
The *Calculate* field indicates what values will be calculated by resection. Tap **Enter**. The following screen appears:



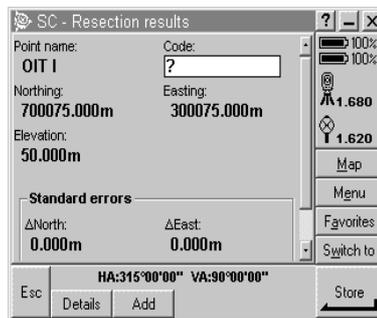
For more information, see Table 19.1, page 349.

3. In the *Point name* field, enter the name of the point you are observing to.
4. In the *Code* field, enter a feature code (optional).
5. Choose an option in the *Method* field. The options are:
 - Angles only – measure the horizontal and vertical angles.
 - Angles and distance – measure the horizontal and vertical angles and slope distance.
6. In the *Target height* field, enter the height of the target you are observing.
7. Sight the center of the target and tap **Measure**.

The measurement information is displayed on the following screen:



8. If the information is correct, tap **Store** to accept the observation. To discard the measurement, tap **Esc** then **Yes**.
9. Repeat steps 5 through 8 for all points that you are using in the resection calculation. When there is enough data for the Trimble Survey Controller software to calculate a resected position, the **Calc** softkey appears. Tap **Calc** to calculate the resection. The following screen appears:



Resection results screen

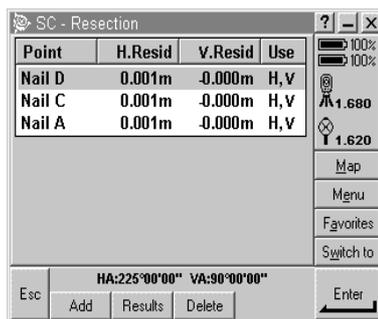
Use the *Resection results* screen to:

- store the results of the resection
- add more observations
- view specific point/observation details

The *Resection results* screen shows the coordinates of the instrument point as calculated by the resection. It also shows the standard errors for the coordinates.

Do one of the following:

- To store the results of the resection immediately, tap **Store**.
- To return to the *Resection observation* screen and observe more points, tap **Add**.
- To view details of the resection, tap **Details**. The following screen appears:



To return to the *Resection results* screen and store the resected point, tap **Results** then **Store**.

Resection details screen

Use the *Resection* details screen to:

- view individual point residuals
- delete observations from the resection
- change which observations are used to compute a solution

To return to the *Resection observation* screen and add more points, tap

Add.

To delete an observation from the resection calculation, highlight it and tap **Delete**.



Warning – You cannot include an observation in a resection once the observation is deleted.

To see what a solution would be like if you deleted a particular observation, access the *Resection point* screen, as shown below. In the *Use* field, select *Off*.

To return to the *Resection results* screen, tap **Results**.

To change which components (horizontal/vertical) of an observation are used in the resection calculation, highlight the point and tap **Enter**.

The following screen appears:

SC - Resection point	
Point name:	Use:
Nail A	H, V
ΔNorth:	ΔEast:
-0.001m	-0.001m
ΔElevation:	Δ H.Angle:
-0.000m	0°00'00"
Δ V.Angle:	Δ S.Distance:
0°00'00"	0.001m
HA:225°00'00" VA:90°00'00"	
Esc	Enter

Resection point screen

The *Resection point* screen shows the residuals of the observed point. The *Use* field shows which components of the observation are used in the resection calculation. See Table 19.2.

Table 19.2 Use field options

Option	Description
H	Use only the horizontal values for that point in the calculation
V	Use only the vertical values for that point in the calculation
H,V	Use both the horizontal and vertical values for that point in the calculation
Off	Do not use the point in the calculation

Note – If you change the *Use* field, the resection recomputes when you accept the screen.

To store the results of a resection, return to the *Resection results* screen.

Unknown Instrument Point Coordinates (to be Provided Later), No Known Points to Use as a Backsight

If the coordinates of the instrument point (the station) are not known and will be provided later:

1. Enter a value in the *Instrument point name* field. The Trimble Survey Controller software warns that the point is not in the database. Tap **Continue**. Any coordinates measured from this point will have null (?) values.
2. Enter a value in the *Instrument height* field.

Note – For a 2D or planimetric survey, leave the *Instrument height* field set to null (?). No elevations are calculated.

3. Enter a value in the *Backsight point name* field. The backsight point is not in the database, so the Trimble Survey Controller software asks if you want to key in the point. Tap **Continue**.
4. In the *Backsight height* field, enter the height of the backsight target.
5. The value in the *Azimuth* field is null (?).
6. Choose an option in the *Method* field. The options are:
 - Angles and distance – measure horizontal and vertical angles and slope distance
 - Angles only – measure horizontal and vertical angles
 - H. Angle only – measure horizontal angle only
7. Sight the center of the backsight target and tap **Measure**. The measurement information is displayed on the following screen:

The screenshot shows the 'SC - Station setup' dialog box. It contains the following fields and values:

- Instrument point name: OIT II
- Instrument height: 1.680m
- Backsight point name: R9
- Backsight height: 1.620m
- Azimuth: ?
- Method: Angles and distance
- Horizontal angle: 225°00'00"
- Vertical angle: 90°00'00"

At the bottom, a status bar displays: HA:225°00'00" VA:90°00'00". Buttons for 'Esc', 'Options', and 'Store' are visible.

8. Tap **Store** to accept the station setup. Station setup is complete.

The instrument point and backsight point can be entered later. Key them in or measure them using GPS. The coordinates of any points measured from that station will then be computed.

Note – When you enter the instrument point later, make sure you delete the original instrument point. The coordinates of any points measured from that station will then be computed.

Alternatively, provide the coordinates later in the Trimble Geomatics Office or Trimble Survey Office software, after transferring the job.

Using the Last Station Setup

You can use the last completed station setup if your instrument is still correctly setup and oriented, you are satisfied that the last station setup is still valid, and you want to continue observing points from this station.

To use the last station setup, tap **Use last** in the station setup screen.

Ending a Conventional Survey

If a survey is running, end it before editing the current survey style or changing survey styles. You must also end the survey before accessing job functions such as copying. For more information, see Chapter 3, Job Operations.

To end a survey, select *End survey* from the *Survey* menu.

If you are operating a robotic instrument remotely, the instrument can be powered down from the remote end (target) once you select *End survey*.

Measuring Points and Rounds

In this chapter:

- Introduction
- Measuring points
- Measuring rounds of observations

Introduction

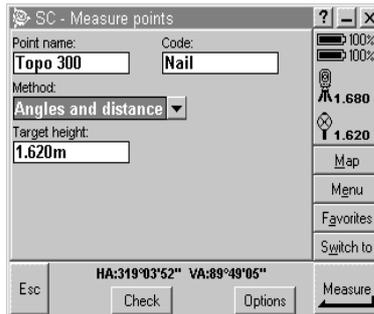
This chapter describes how to measure topo and check points with a conventional instrument. These are the only points you can measure in a conventional survey. The chapter also describes how to measure multiple sets (rounds) of observations.

Measuring Points

This section shows you how to measure points using a conventional instrument and the Trimble Survey Controller software.

Measure Points Screen

When station setup is complete, select *Measure points* from the *Survey* menu. The following screen appears:



To change the settings for the current survey, tap **Options**. It is not possible to change the current survey style or the system settings.

If you are using a servo or robotic instrument to measure a known (coordinated) point, tap **Turn** or select the *Stakeout auto turn* check box in the survey style to automatically turn the instrument to the point.

Measuring a Topo Point

To measure a topographic point using the Trimble Survey Controller software and a conventional instrument:

1. Enter a value in the *Point name* field.
2. If necessary, enter a feature code in the *Code* field.
3. In the *Method* field, select a measurement method. See Choosing a Method (Topo Points), below.
4. Enter a value in the *Target height* field. Tap .

If you selected the *View before storage* check box in the survey style, the measurement information appears on the screen. If necessary, edit the target height and code. Then do one of the following:

- Tap to store the point.
- Turn the instrument to the next point and tap . The last point is stored and a measurement is made to the next point.

If you did not select the *View before storage* check box, the point is stored automatically and the point name increments (based on the *Auto point step size* setting).

The Trimble Survey Controller software stores the raw observations (HA, VA, and SD).

Choosing a Method (Topo Points)

Choose one of the following methods for measuring topo points:

- Angles and distance – measure the horizontal and vertical angles and slope distance.
- Angles only – measure only the horizontal and vertical angles.
- H. Angle only – measure only the horizontal angle.

- H. Angle offset – first measure the vertical angle and slope distance then the horizontal angle to an inaccessible point.
- Single dist. offset – measure horizontal and vertical angles and slope distance to a target, then computes a new position from the target to a specified direction and distance.

If you measure a point by an *Angles only*, *H. Angle only* or *H. Angle offset* method using a robotic instrument operated from the remote end (target), make sure the instrument is tracking the target. If tracking is not maintained, the current orientation of the instrument will be used for the measured angles.

Horizontal Angle Offset

Use the *H. Angle offset* method when the point to be measured is inaccessible, for example, the center of a tree.

To measure a point using this method:

1. In the *Point name* field, enter the name of the point.
2. In the *Code* field, enter a feature code (optional).
3. In the *Method* field, select *H. Angle Offset*.
4. In the *Target height* field, enter the height of the target.
5. Place the target beside the object to be measured, sight the target, and tap .

The *Horizontal angle* field contains a null (?) value.

6. Turn the target to the center of the object and tap . The Trimble Survey Controller software inserts the measured value in the *Horizontal angle* field and:
 - if you selected the *View before storage* check box in the survey style, the measurement values are displayed. Tap to store the point.
 - if you did not select the *View before storage* check box, the point is stored automatically.

Single distance offset

Use the *Single dist. offset* method when a point is inaccessible but a horizontal distance from the target point to the object can be measured.

To measure a point using this method:

1. In the *Point name* field, enter the name of the point.
2. In the *Code* field, enter a feature code (optional).
3. In the *Method* field, select *Single dist. offset*.
4. In the *Target height* field, enter the height of the target.
5. In the *Distance* field, enter the horizontal distance from the target (prism) point to the object to be measured.
6. In the *Direction* field, enter the direction from the target (prism) point to the object to be measured. Figure 20.1 shows how the directions are defined.

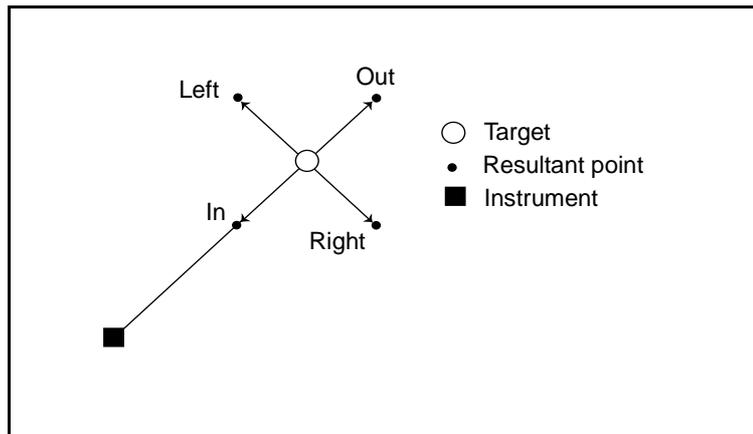


Figure 20.1 Direction options

If you are operating a robotic instrument remotely from the target, the left/right directions are reversed. However, the measurement is stored relative to the instrument position.

7. Tap **Measure**:
 - If you selected the *View before storage* check box in the survey style, the observation adjusted for the offset distance appears. Tap **Store** to store the point.
 - If you did not select the *View before storage* check box, the point is stored automatically.

The Trimble Survey Controller software stores the adjusted horizontal angle, vertical angle, and slope distance in the point record, as well as an offset record with the offset measurement details.

Measuring a Point in Two Faces

The Trimble Survey Controller software lets you make face 1 and face 2 (direct and reverse) measurements at any time and in any order. It averages a pair of observations in a matched pair record. It then averages multiple matched pair records (rounds of observations) in a mean turned angle record.

For more information on checking face 1 and face 2 tolerances, see Duplicate point actions, page 339.

***Note** – You can measure points using either face in any order (for example, BS FS FS BS or BS FS BS FS). However, if you observe the backsight only on face 1, only face 1 observations to points are coordinated. Points observed on face 2 are coordinated when the backsight is observed on face 2.*

To measure a point using both faces:

1. Complete a station setup.
2. Measure a point. For more information, see Measuring a Topo Point, page 361.
3. Measure the same point again on the opposite face of the instrument. In the *Point name* field, use the same name as in step 2.

The Trimble Survey Controller software writes a matched pair record immediately after the observation on the opposite face is stored. This matched pair record contains the mean horizontal angle, the mean vertical angle, and the mean slope distance from the two previous observations.

Immediately after a matched pair record, the Trimble Survey Controller software writes a mean turned angle record. This record contains the mean horizontal angle, the mean vertical angle, and the mean slope distance from all previous matched pairs observed from the current station setup.

The mean slope distance displayed in the mean turned angle record in the Trimble Survey Controller software has been reduced for PPM, curvature and refraction, and prism constant. The raw mean slope distance is exported to the DC file and reduced in the Trimble Geomatics Office software.

If you make another pair of face 1 and face 2 observations during the same station setup, another matched pair record is written to the database and a new updated mean turned angle record is written. The previous mean turned angle record disappears.

Note – If you change the target height between the two observations, the Trimble Survey Controller software reduces the face 1 and face 2 observations to HA HD VD, and produces a matched pair that is the mean HA HD VD. The same happens to the mean turned angle record when you change the target height between matched pair records.

If you observe a point using the Angles and distances method and then make a second (face 2) observation to it using the Angles only method, you must still observe to the center of the target. The Trimble Survey Controller software averages the vertical angle measurements in the matched pair record. Alternatively, use the H. Angle only method.

Backsight

When you observe points on both faces, remember to observe the backsight on both faces. Once the backsight has been observed on face 1 and face 2, a matched pair record is written for the backsight. The orientation correction for any foresight points with a matched pair record is then based on the backsight matched pair record.

If you are using a servo or robotic instrument, use the **Chg face** softkey in the *Instrument / Instrument controls* menu to change face.

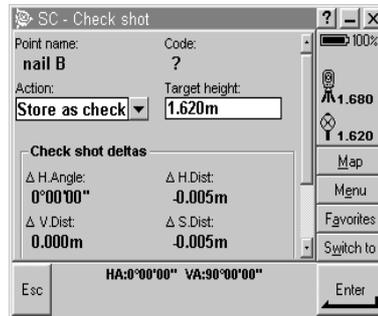
Measuring a Check Point

To measure a check point or to check the backsight, tap **Check** in the *Measure points* screen. The following screen appears:

To measure a check point:

1. In the *Point name* field, enter the name of the point to check.
2. In the *Method* field, select a measurement method and enter the required information in the fields that appear.
3. In the *Target height* field, enter the height of the target. Tap **Measure**.

If you did not select the *View before storage* check box, the point is stored with a classification of *check*. If you selected the *View before storage* check box, the check shot deltas appear on the following screen:



When you observe the point:

If the station setup is the same as when you originally measured the point, the deltas are the difference in observation values between the original observation and the check observation. The deltas displayed are: horizontal angle, vertical distance, horizontal distance, and slope distance.

If the station setup is different from when you originally measured the point, the deltas are in terms of the best coordinates from the original point to the check point. The deltas displayed are as follows: azimuth, vertical distance, horizontal distance, and slope distance.

4. Tap **Enter** to store the check point. Tap **Esc** to abandon the measurement.

Tap **Chk BS** to display the *Check backsight* screen. This is similar to the *Check point* screen, but the *Point name* field shows the backsight of the current station setup. You cannot edit this field.

To observe a check shot to the backsight, use the same procedure as described above.

To return to the *Check point* screen, tap **Chk topo**.

Measuring Rounds of Observations

This section shows you how to measure multiple sets (rounds) of observations with a conventional instrument and the Trimble Survey Controller software. A round consists of a set of both face 1 and face 2 observations.

With rounds, you measure the first face observations. The Trimble Survey Controller software builds the rounds list then guides you through a specified number of rounds of observations by:

- directing you to change face when required, or doing so automatically with servo-driven instruments.
- defaulting to the correct point details for each observed station
- displaying the results and letting you delete bad data

Building the Rounds List

The rounds list contains the points used in the rounds observations. The Trimble Survey Controller software automatically builds this list during the first round of observations made on the first face (typically face 1). The backsight point observed during station setup is added to the list first. The last point is added when the first round of observations is completed on the first face.

When a point is added to the rounds list, the Trimble Survey Controller software takes note of the following details:

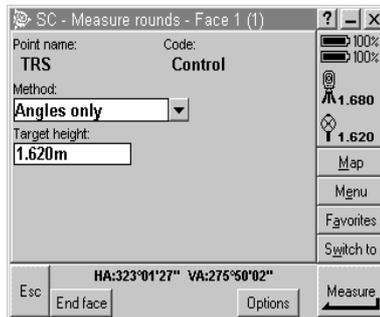
- point name
- feature code
- target height
- prism constant
- observation method

The Trimble Survey Controller software uses this information as the default values for all subsequent rounds observations.

The rounds list cannot be edited, so observe all points that are to be included in the rounds observations during the first round on the first face.

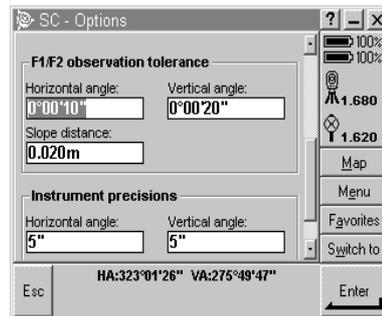
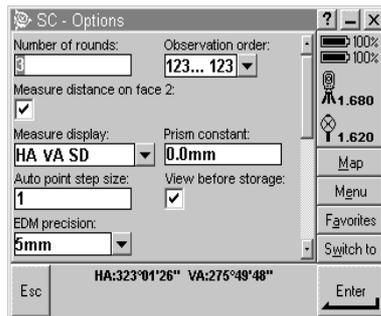
To add a point to the rounds list:

1. Complete a station setup. For more information, see *Station Setup*, page 345. The backsight point will be added to the rounds list first.
2. From the *Survey* menu, select *Measure rounds*. The following screen appears:



The top of the *Measure rounds* screen shows which face the instrument is on, and the number of the current round (shown in brackets). For example, this screen shows that the instrument is on face 1 of the first round.

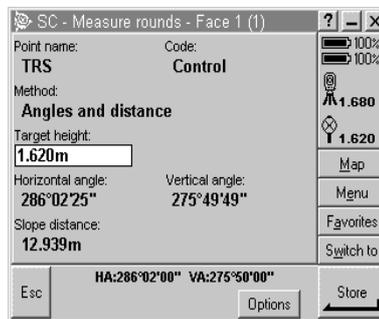
3. To change the settings for the current survey, tap **Options**. The following screens show two of the available options:



Use the *Options* screen to specify the prism constant of the target for each observation in the rounds list. Enter a negative value if the prism constant is to be subtracted from measured distances.

- To add a point to the rounds list, follow the same procedure for measuring a topo point. For more information, see *Measuring a Topo Point*, page 361.

If you selected the *View before storage* check box in the survey style, the measurement information is displayed, as shown in the following screen:



If you did not select the *View before storage* check box, the point is stored automatically, and the point name increments according to the value in *Auto point step size*.

- When the rounds list is complete, tap **End face**. The Trimble Survey Controller software prompts you for the next point to be measured in the rounds of observations.

Note – If you tap **Esc** in the *Measure rounds* screen, the current rounds list is lost. A new station setup is required to start another round.

Measuring a Point in a Round of Observations

When the rounds list has been built, the *Measure rounds* screen displays the default target details for the next point to be observed.

If the TSCe data collector is connected to a servo or robotic instrument, and you selected the *Stakeout auto turn* check box in the survey style, the Trimble Survey Controller software automatically turns the instrument to the calculated horizontal and vertical angle.

Note – When using servo or robotic instruments, check that the instrument has sighted the target accurately, and manually adjust it if necessary. Some instruments can perform accurate sighting automatically. For information on the instrument specifications, refer to the instrument manufacturer’s documentation.

Making a measurement

Once the rounds list has been built, the Trimble Survey Controller software automatically displays the last used target information for the next point to be measured.

To measure a point, tap . When the observation is stored, the Trimble Survey Controller software enters the point name and the target information as default values for the next point in the rounds. Repeat this procedure until all observations are completed on the face.

Note – If you observe a point on the wrong face, the Trimble Survey Controller software will display a warning when you try to store the point.

When all observations are complete, the Trimble Survey Controller software displays the results for the round. For more information, see *Viewing the Results*, page 374.

If you cannot complete the observations, tap . The following warning message appears.

Please confirm: Not all points have been observed. End observations on this face?

Tap to confirm that you want to end observations on this face and begin observing the next set of rounds.

If you selected the *Measure distance on face 2* check box, the measurement method for observations on face 2 will always use *Angles only* by default.

If the TSCe data collector is connected to a servo or robotic instrument, the **Turn** softkey is available. After a point is stored, tap **Turn** to automatically turn the instrument to the next target. If you selected the *Stakeout auto turn* check box in the survey style, the instrument will automatically turn.

Duplicate Point Actions (Rounds)

The Trimble Survey Controller software treats points in rounds observations according to the survey style settings in the *Duplicate point actions* screen. For more information, see Duplicate point actions, page 339.

If you use the default settings in the *Duplicate points action* screen, the *Duplicate point: Out of tolerance* screen appears every time a point of the same name is observed. If you change the settings, the *Duplicate point: Out of tolerance* screen appears only when the tolerance values have been exceeded.

For larger scale surveys, you may need to increase the *Duplicate point tolerance* settings for the survey style. Set the tolerances at an appropriate value to check for gross errors, and examine the observation residuals for better quality control. For more information on viewing the observation residuals, see Viewing the Results, page 374.

When a new point is further from the point observed in the previous round than the tolerance specified in the survey style, the *Duplicate point: Out of tolerance* screen appears. Select one of the following options in the *Action* field:

- Discard – discard the point without storing it.
- Store another – store the point.

Duplicate Backsight Point

When the orientation is changed between consecutive rounds, that is the backsight point is re-observed in the new round, the *Duplicate backsight point* screen appears. The options are:

- Discard – discard the observation without storing
- Store and reorient – store another observation that provides a new orientation for subsequent points measured in the current round. Previous observations are not changed.

F1/F2 Observation Tolerance

If the face 1 and face 2 observations are out of tolerance, the *Observation: Out of tolerance* screen appears. The options are:

- Discard – discard the observation without storing
- Store another – store the observation, the matched pair and the mean turned angle

Note – To change the F1/F2 Observation tolerance setting during the survey, tap **Options** from the Measure rounds screen.

Skipping Observations

During rounds observations, if the current point cannot be measured, tap **Skip** to skip an observation. The Trimble Survey Controller software will then default to the next point in the rounds list.

You cannot skip observations:

- when building the rounds list
- if the observations are made to the first point (backsight) in the rounds list

When the Trimble Survey Controller software reaches the end of a rounds list in which points have been skipped, the following message appears:

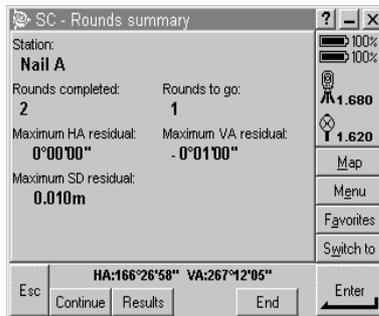
Observe skipped points?

Tap Yes to observe the points that were skipped during that round. The observations can be skipped again if required. Tap No to end the round.

Points that are skipped on the first face are automatically skipped on the second face. Similarly, if a point is skipped on the second face, the first face observation will be ignored. If a point is skipped in one round, all subsequent rounds continue to prompt for observations to that point.

Viewing the Results

At the end of each round, the following screen appears:



Use the *Rounds summary* screen to:

- continue (observe more rounds)
- view specific point/observation details
- end the current rounds session

The *Rounds summary* screen shows details of the rounds that have been completed. The maximum residuals are displayed for quick reference.

Note – In 2D surveys where the instrument or target heights are null, the observed vertical angle and slope distance residuals and standard deviation are displayed as N/A.

Do one of the following:

- To return to the *Measure rounds* screen and observe another round, tap **Continue**.
- To end the current rounds session, tap **End**.

To view details of the observations, tap **Results**. The following screen appears:

Point	Mean HA	Std. Dev
TRS	0°00'00"	0°00'00"
Nail B	253°11'33"	0°00'00"
OIT 3	220°47'04"	0°00'00"
Nail C	135°50'56"	0°00'00"

HA:166°26'58" VA:267°12'02"

Esc VA SD Enter

Map, Menu, Favorites, Switch to

To return to the *Rounds summary* screen, tap **Esc**.

Station details screen

Use the *Station details* screen to:

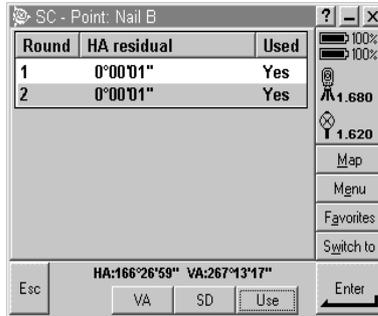
- view the observation details from the current station in the round
- view individual point residuals and remove bad observations from a round

The *Station details* screen shows the mean (turned) horizontal angle and standard deviation for all points observed from the station. To change the observation display view, do one of the following:

- Tap **VA** to display the mean vertical angle.
- Tap **SD** to display the mean slope distance.

To return to the mean horizontal angle view, tap **HA**.

To view individual point residuals for each round and remove bad observations, highlight the point and tap **Details**. The following screen appears:



Point details screen

The *Point* details screen shows the residuals of the observed point for each round. The *Use* column shows the observations in use (displayed as *Yes*), and those that have been removed (displayed as *No*). If observations have been skipped in a round, *N/A* is displayed.

Use the **HA**, **VA**, or **SD** softkeys to change the residual display views.

If the residuals for an observation are high, it may be better to disable the observation from the round. To disable an observation component (HA, VA or SD), highlight it and tap **Use**.

If you select No in the *Use* field, the pairs of observations (face 1 and face 2) made to the point in the round are deleted. The mean observations, residuals, and standard deviations are recalculated.

The **Use** softkey is not available for backsight points. Observations to the backsight are used to orientate observations and cannot be deleted.

To accept the changes and return to the *Station* details screen, tap

Enter.

Conventional Stakeout

In this chapter:

- Introduction
- General procedure

Introduction

This chapter shows how to stake out points, lines, arcs, and digital terrain models (DTM) using a conventional instrument.

For information about staking out a road, see Chapter 6, *Roading*.



Warning – Do not stake out points and then change the coordinate system or perform a calibration. If you do, these points will be inconsistent with the new coordinate system and with points staked out after the change.

General Procedure

To stake out a point, set up the conventional instrument and complete a station setup:

1. If necessary, change the stakeout configuration. For more information, see the next section.
2. Define the point/line/arc/DTM. To do this, use one of the following methods:
 - key in data
 - transfer a file from a PC
 - calculate coordinates using one of the Cogo functions
3. Use one of the following methods to select a point:
 - From the map, select the feature to be staked out—points, lines or arcs.
 - From the main menu, choose *Survey / Stakeout*. Then select the feature to be staked out.

4. Turn the conventional instrument to the angle indicated on the screen. If you are using a servo or robotic instrument, tap to turn the instrument to the angle indicated on the screen. Alternatively, select the *Stakeout auto turn* check box in the survey style.

If you are operating a robotic instrument remotely and the lock is maintained, the instrument will automatically track the prism as it moves. The stakeout graphical display will update accordingly.

The graphics indicate when the instrument is on line.

5. Move the target so that it is on line and tap . Adjust the target distance from the instrument as indicated by the graphics, and measure again.
6. When the graphical display indicates that the target is on the point, tap .
7. Store the as-staked point. (This step is optional.)
8. Repeat steps 5 and 6 until all points are staked out.
9. End the survey.

Stakeout Settings

You can change the default values for as-staked points, and also change how certain values are displayed during stakeout.

To specify which distances are used and displayed by the Trimble Survey Controller software:

1. From the main menu, select *Configuration / Job / Cogo settings*.
2. Configure the *Distances* field. For example, to apply sea level (ellipsoid level) correction, select *Ellipsoid*.

To change the format:

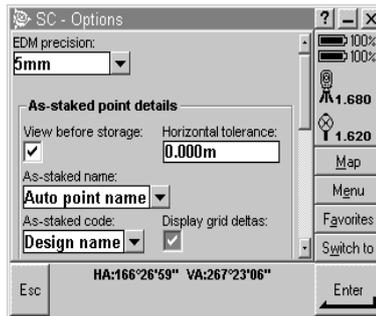
1. From the main menu, select *Configuration / Job / Units*.
2. Configure the *Stationing* field. Stationing values can be displayed in the following formats: 1000.0, 10+00.00, or 1+000.0.

To change the stakeout configuration for a survey style:

1. From the main menu, select *Configuration / Survey Style*.
2. Highlight your conventional survey style and tap **Edit**.
3. Select *Stakeout*. For more information about the fields that can be edited, see page 338.

To change the stakeout configuration for the current survey only:

1. From the *Stakeout* screen, tap **Options**. The following screen appears:



2. Configure each field as required. For more information, see Stakeout, page 338.

Using the Graphical Display During Stakeout

When staking out a point, line, arc, or road, you can use the text on the right of the screen or the graphical display on the left to navigate to the point. This section describes how to use the graphical display.

In general, a solid/filled arrow means action. Use these arrows to locate the point within a certain tolerance. You can configure the tolerances for both angles and distances in the *Options* screen.

The stakeout graphical display operates in one of two modes: Distances, or Angle and distance. To choose a mode, select *Display/Deltas* in the *Options* screen. The next section shows examples of each mode.

To use the graphical display during stakeout:

1. When you select a point to stake out, the following screen appears:



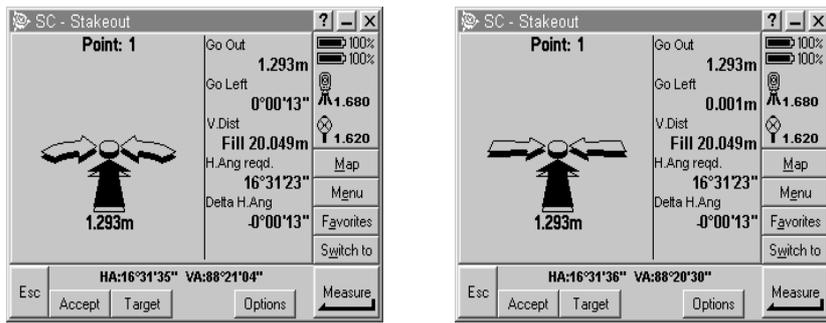
A large arrow indicates the direction in which the instrument must be turned. The screen also indicates the angle that the instrument must display.

If you are using a servo or robotic instrument, tap to turn the instrument to the angle indicated on the screen.

Alternatively, select the *Stakeout auto turn* check box in the survey style.

If you are operating a robotic instrument remotely from the target, the graphical display is reversed and the arrows are shown from the target (prism) to the instrument.

2. When the instrument is within the angular tolerance, the graphical display shows two hollow/outline arrows. (Use the *Options* screen to specify the angular tolerance.)
3. Tap **Measure**. When the distance measurement is made, a screen appears, similar to one of those shown below appears:

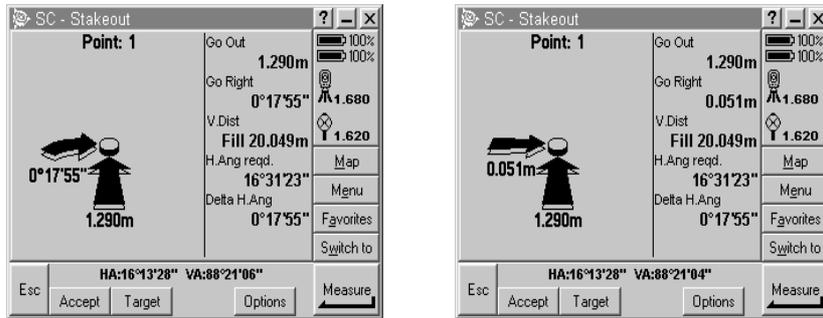


The left and right arrows are curved or straight depending on the mode selected in the *Options* screen:

- In the left screen, the *Display/Deltas* field is set to *Angle and distance*. The arrows are curved.
- In the right screen, the *Display/Deltas* field is set to *Distances*. The arrows are straight.

The hollow left and right arrows show that the instrument is on line. The solid arrow indicates that the target must move away from the instrument.

- When the target has moved, tap **Measure** again. If the instrument is turned off line, the two hollow arrows disappear and a solid arrow appears. The following screens show two different ways to view this:



- In the left screen above, the *Display/Deltas* field is set to *Angle and distance*. The instrument must be turned to the left by the amount shown. When the instrument is on-line again, the two hollow arrows reappear. Direct the target on line.

The up/down arrow indicates that the target must move towards the conventional instrument.

- In the right screen, the *Display/Deltas* field is set to *Distances*. The target must move to the left. The instrument is then turned to follow the target. When the instrument is on line, the two hollow arrows reappear.

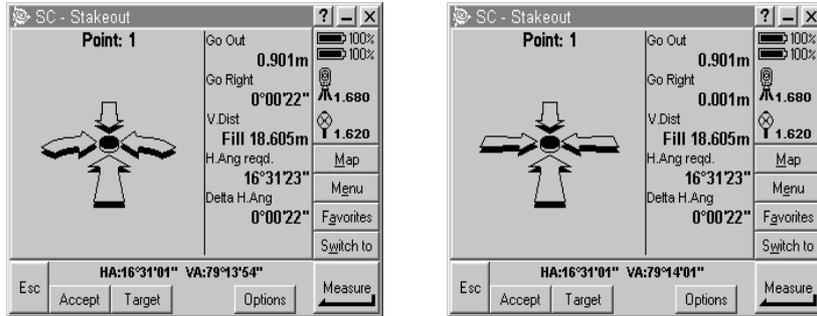


Tip – If you are using a servo instrument, tap **Turn** to turn the instrument back on line.

- When the target has moved, tap **Measure** again.

If the instrument is on line, two left/right hollow arrows appear. If the distance is not yet correct, a solid up/down arrow shows the direction and amount that the target must move towards or away from the instrument.

6. Tap **Measure** again. If the measurement to the target is within the angular and distance tolerances specified in the *Options* screen, four hollow arrows appear and the center point is filled in, as shown in the following screens:



If you are operating a robotic instrument remotely, the instrument automatically tracks the prism as it moves and continuously updates the graphical display. If a measurement to the target is within the angular and distance tolerances, tap **Measure**.

7. Do one of the following:
- To record the as-staked point:

If you selected the *View deltas before storage* check box, tap **Accept**. The measurement and the stakeout deltas are displayed. Tap **Store** to store the point.

If you did not select the *View deltas before storage* check box, tap **Store** to store the point.
 - To abandon the as-staked point without recording it, tap **Esc** then **Yes**. You return to the list and can stake out more points.

Staking Out a Point

To stake out a point:

1. Perform a station setup. For more information, see Chapter 19, Starting a Conventional Survey.
2. From the map, select the point(s) to be staked out. Tap **Stakeout**.

If you selected more than one point from the map for staking out, the *Stake out points* screen appears. Proceed to the next step. If you selected one point from the map, go to step 4.

3. The *Stake out points* screen lists all points selected for stakeout. To add more points to the list, tap **Add** to select points in the Trimble Survey Controller database or in a comma delimited (.csv, or Comma Separated Values) file. Choose the method by which points are to be selected.

Use the *Select from list* option to select from a list of all points in the Trimble Survey Controller database. Use the *Select from file* option to select points in a comma delimited file.

Note – If two points have the same name, only the point with the higher class—or the first point in a .csv file—is displayed.

4. To select a point for stakeout, highlight the point from the *Stake out points* screen and tap **Stakeout**.

The following screen displays the angle to which you should turn the instrument and the distance from the instrument to the point, together with a graphical representation of this:



5. Use the graphical display screen, or the text display, to navigate the target to the point. For more information, see *Using the Graphical Display During Stakeout*, page 381.
6. When all arrows are hollow, to mark the point, do one of the following:
 - To record the as-staked point:

If you selected the *View deltas before storage* check box, tap **Accept**. The measurement and the stakeout deltas are displayed. Tap **Store** to store the point.

If you did not select the *View deltas before storage* check box, tap **Store** to store the point.
 - To abandon the as-staked point without recording it, tap **Esc** then **Yes**. You return to the list and can stake out more points.

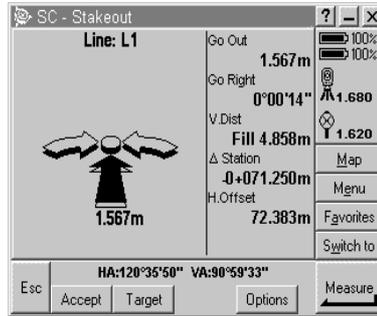
Staking Out a Line

To stake out a line:

1. Perform a station setup. For more information, Chapter 19, *Starting a Conventional Survey*.
2. From the map, select the line to be staked out. Tap **Stakeout**. The *Stake out line* screen appears.
3. The selected line is displayed in the *Line name* field. To select another line in the *Line name* field, use one of the following methods:
 - Tap  to display a list of lines selected from the map. Tap the required line to select it. If necessary, reselect the line from the map.
 - Tap **List** to display a list of lines stored in the Trimble Survey Controller database. Tap the required line to select it.
 - Tap **Key in** and define the line to be staked out.

4. Enter a value in the *Target height* field.
5. Select an option in the *Stake* field and enter the required information. For more information, see Stake options, page 389.
6. Tap **Start**. The TSCe data collector displays a large arrow that indicates the direction in which you must turn the instrument.
7. When the target is on line with the instrument, tap **Measure**. The following fields contain values if they are appropriate to the stakeout method used:
 - *H. Dist reqd* – the horizontal distance from the instrument to the line or station on the line.
 - *H. Ang reqd* – the horizontal angle reading that should appear on the instrument to point in the direction of the line or station on the line.
 - *Delta H. Ang* – the angle that the instrument needs to turn to point in the direction of the line or station on the line.
 - *Go In/Out* – the horizontal distance along the instrument line of sight, to the line or station on the line.
 - *Go Left/Right* – the horizontal distance perpendicular to the instrument line of sight, to the line of station on the line.
 - *V. Dist (cut/fill)* – the vertical distance between the target position and the point on the line to be staked out.
 - *Stationing* – the station/chainage of the target position perpendicular to the line.
 - Δ *Station* – the difference in the stationing between the target position and the station to be staked out. A positive value means that the station to be staked out is towards the beginning of the line. A negative value means that the station to be staked out is towards the end of the line.
 - *H. Offset* – the offset of the target position in relation to the line. A positive value is an offset to the right and a negative offset is an offset to the left.

- *Grade to line* – the grade of the slope between the target position and the closest point on the line.
8. Use the graphical display or the text display to navigate the target to the point, as shown in the following screen:



For more information, see *Using the Graphical Display During Stakeout*, page 381.

9. When all four arrows are hollow, mark the point. Do one of the following:
- To record the as-staked point:
 - If you selected the *View deltas before storage* check box, tap **Accept**. The measurement and the stakeout deltas are displayed. Tap **Store** to store the point.
 - If you did not select the *View deltas before storage* check box, tap **Store** to store the point.
 - To abandon the as-staked point without recording it, tap **Esc** then **Yes**. You return to the *Stakeout/Line* screen. Tap **Sta-** or **Sta+** to select the next station on the line, and stake out the points as described above.

Stake options

When staking out a line, the options for the *Stake* field are:

- Station on the line – enter the station to be staked out.
- Station/offset from line – enter the station to be staked out, a horizontal offset, and a vertical offset.
- Slope from line – enter the slope parameters for a slope to the left and/or right of the line as required.

Staking Out an Arc

To stake out an arc:

1. Perform a station setup. For more information, see Chapter 19, *Starting a Conventional Survey*.
2. From the map, select the arc to be staked out. Tap **Stakeout**. The *Stake out line* screen appears.
3. The selected line is displayed in the *Line name* field. To select another line in the *Arc name* field, use one of the following methods:
 - Tap  to display a list of arcs selected from the map. Tap the required arc to select it. If necessary, reselect the arc from the map.
 - Tap **List** to display a list of arcs stored in the Trimble Survey Controller database. Tap the required arc to select it.
 - Tap **Key in** and define the arc to be staked out.
4. Enter a value in the *Target height* field.
5. Choose a setting in the *Stake* field and enter the required information. For more information, see *Stake options*, page 391.
6. Tap **Start**. The TSCe data collector displays a large arrow that indicates the direction in which you must turn the instrument.

7. When the target is on line with the instrument, tap . The following fields contain values if they are appropriate to the stakeout method used:
- *H. Dist reqd* – the horizontal distance from the instrument to the arc or station on the arc.
 - *H. Ang reqd* – the horizontal angle reading that should appear on the instrument to point in the direction of the arc or station on the arc.
 - *Delta H. Ang* – the angle that the instrument needs to turn to point in the direction of the arc or station on the arc.
 - *Go In/Out* – the horizontal distance along the instrument line of sight, to the arc or station on the arc.
 - *Go Left/Right* – the horizontal distance, perpendicular to the instrument line of sight, to the arc or station on the arc.
 - *V. Dist (cut/fill)* – the vertical distance between the target position and the point on the arc to be staked out.
 - *Stationing* – the station/chainage of the target position, perpendicular to the arc.
 - Δ *Station* – the difference in the stationing between the target position and the station to be staked out. A positive value means that the station to be staked out is towards the beginning of the arc. A negative value means that the station to be staked out is towards the end of the arc.
 - *H. Offset* – the offset of the target position in relation to the arc. A positive value is an offset to the right and a negative offset is an offset to the left.
 - *Grade to arc* – the grade of the slope between the target position and the closest point on the arc.

8. Use the graphical screen display or the text display to navigate the target to the point, as shown in the following screen:



For more information, see *Using the Graphical Display During Stakeout*, page 381.

9. When all four arrows are hollow, mark the point. Do one of the following:
- To record the as-staked point:

If you selected the *View deltas before storage* check box, tap **Accept**. The measurement and the stakeout deltas are displayed. Tap **Store** to store the point.

If you did not select the *View deltas before storage* field, tap **Store** to store the point.
 - To abandon the as-staked point without recording it, tap **Esc** then **Yes**. You return to the *Stakeout/Arc* screen. Tap **Sta-** or **Sta+** to select the next station on the arc, then stake out the points as described above.

Stake options

When staking out an arc, the options for the *Stake to* field are:

- Station on the arc – enter the station to be staked out.
- Station/offset from arc – enter the station to be staked out and any horizontal and vertical offset.

- Slope from arc – enter the slope parameters for a slope to the left and/or right of the arc, as required.
- Intersect point of arc.
- Center point of arc.

Staking Out a Digital Terrain Model

To stake out a DTM:

1. From the main menu, select *Survey / < Conventional Survey Style>*.
2. Select *Station Setup* and perform a station setup. For more information, see Chapter 19, Starting a Conventional Survey.
3. Select *Stakeout / DTMs*. The *Stake out DTM* screen appears.
4. In the *DTM* field, select the terrain model to be staked out.
5. Enter a value in the *Target height* field and, if needed, the *Vertical offset* field. Tap .
6. When the graphical display screen appears, tap .
The screen displays the coordinates of the current position and the vertical distance above (cut) or below (fill) the DTM.
7. Do one of the following:
 - To record the point:
If you selected the *View deltas before storage* check box, tap . The measurement and the stakeout deltas are displayed. Tap to store the point.
If you did not select the *View deltas before storage* check box, tap to store the point.
The Trimble Survey Controller software stores the point and the stakeout deltas.
 - To abandon the point without recording it, tap then . You return to the list and can stake out more points.
8. Tap to return to the *Stakeout/DTM* screen.

Staking Out a Road

To stake out a road using a conventional instrument, use the graphical screen shown in *Using the Graphical Display During Stakeout*, page 381. For more information about staking out a road, see Chapter 6, *Roading*.

Conventional Instrument Menu

In this chapter:

- Introduction
- Station setup details
- Instrument controls
- Target

Introduction

The *Instrument* menu provides information about the instrument that is connected to the TSCe data collector. This menu appears when you choose the *Instrument* icon from the main menu.

If a conventional instrument is connected to the data collector, the items in the *Instrument* menu are:

- Station setup details
- Target
- Instrument controls (optional—this is available when a servo or robotic instrument is connected).

Station Setup Details

If the TSCe data collector is connected to a conventional instrument, select *Instrument / Station setup details* to view the instrument type and current station setup information.

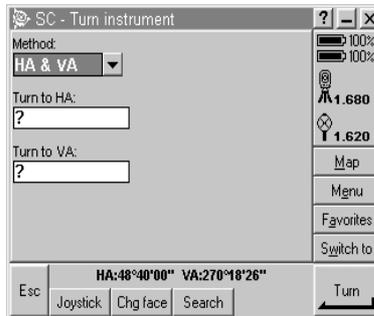


Tip – You can also access the station setup details from the status bar by tapping the conventional instrument icon.

If you are connected to a servo or robotic instrument, tap the conventional instrument icon to open the *Instrument controls* screen.

Instrument Controls

If the TSCe data collector is connected to a servo or robotic conventional instrument, use the *Instrument controls* option to control the movement of the instrument, as shown in the following screen:



If you are using a robotic instrument, you can use the TSCe data collector to operate the instrument remotely by radio. This lets the TSCe data collector guide the instrument to measure or stakeout points from the target (prism).



Tip – To access the *Instrument controls* screen, tap the instrument icon on the status bar.

Turning the Instrument

Choose one of the following methods to turn the instrument:

HA & VA

To turn the instrument to a specified angle, do one of the following:

- To turn the instrument to a horizontal angle only, enter the horizontal angle in the *Turn to HA* field. Tap .
- To turn the instrument to a horizontal and vertical angle, enter the horizontal angle in the *Turn to HA* field and the vertical angle in the *Turn to VA* field. Tap .

The instrument turns to the angle(s) you entered.

Point Name

To turn the instrument to a specified point, enter a point name in the *Point name* field and tap .

The instrument turns to the point you entered.

Changing the Face

To switch between face 1 and face 2 (direct and reverse) of the instrument, tap .

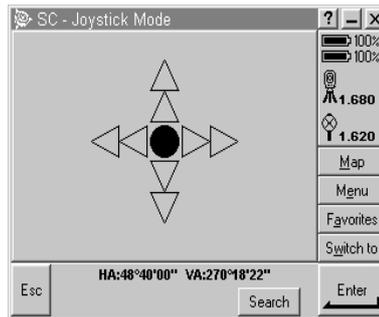
The message Please wait. Instrument turning appears and then the instrument turns to the opposite face.

Locating and Locking on to the Target

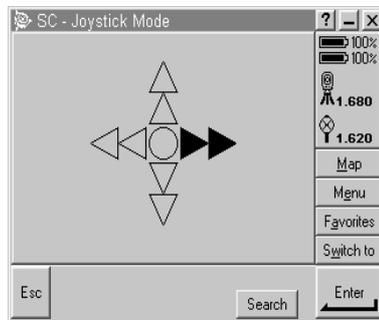
When you operate the instrument remotely from the target (prism), the **Joystick** softkey appears in the *Instrument controls* screen. Use the softkey to turn the instrument towards the target when lock has been lost.

To turn the instrument towards the target:

1. Tap **Joystick**. The following screen appears:



2. Tap an arrow on the screen or press , , , and  on the keypad to select a direction to turn the instrument. The instrument will turn in the direction indicated by the solid/filled arrow, as shown in the following screen:



Note – When the instrument is on face 2, the up and down arrows are reversed. For example, if you press , the instrument will turn in an upwards direction. If you press , the instrument will turn in a downwards direction.

3. Select the same direction to increase the instrument turning speed. The second directional arrow becomes solid. Select the same arrow to decrease the speed again.
4. Tap or another arrow to stop the instrument from turning. The directional arrows become hollow. The instrument now points towards the target.

To make the instrument locate and lock on to the target:

- Tap .

The message Searching... appears on the screen and the instrument starts searching for the target.

The search results appear as the following status line messages:

- Target Locked – indicates that the target has been located and tracking locked.
- Target Detected – indicates that the target has been located (when the instrument is in servo mode).
- No Target – indicates that the target was not located.

Tracklight Support for Trimble and Geodimeter Robotic Instruments

When you use a Trimble 5600 Series and Geodimeter System 600 Robotic instrument that is set up with a Tracklight unit, you can use the Trimble Survey Controller software to set the intensity of the guide-light.

To set the Tracklight unit:

1. Tap .
2. Do one of the following:
 - Tap to emit the guide-light at a high intensity.
 - Tap to emit the guide-light at normal intensity.
 - Tap to turn the Tracklight unit off.

Target

If the TSCe data collector is connected to a conventional instrument, select *Instrument / Target* to view the target height and the prism constant currently in use.



Tip – To access the target details, tap the prism icon on the status bar.

Laser Observations

In this chapter:

- Introduction
- Configuring the Trimble Survey Controller software
- Configuring the laser
- Taking a measurement with the laser rangefinder
- Laser softkey

Introduction

If a point cannot be occupied directly by a GPS rover, one way to measure it is to use a laser rangefinder with the Trimble Survey Controller software. This combination of laser rangefinder and Trimble Survey Controller software can also be used with a conventional instrument. Alternatively, the laser rangefinder can be plugged into the TSCe data collector and used on its own with the Trimble Survey Controller software.

The Trimble Survey Controller software supports the following laser rangefinders:

- Laser Technology Criterion 300
- Laser Technology Criterion 400
- Laser Technology Impulse
- Laser Atlanta Advantage CI
- Leica Disto memo
- Leica Disto pro
- MDL LaserAce 300
- MDL Generation II Surveyor

Note – Contact your local Trimble dealer for a current list of lasers supported by the Trimble Survey Controller software.

Configuring the Trimble Survey Controller software

Before you use a laser rangefinder with the Trimble Survey Controller software, you must configure an appropriate survey style. A laser rangefinder can be used with any survey style.

To configure the survey style:

1. From the main menu, choose *Configuration / Survey styles*. Highlight a survey style and tap .
2. Select *Laser rangefinder*.

3. Select one of the instruments in the *Type* field.
4. If necessary, configure the *Controller port* and *Baud rate* fields.

The default value in the *Baud rate* field is the manufacturer's recommended setting.

If the Trimble Survey Controller software can automatically instruct the laser to take a measurement when you tap , you can edit the *Auto measure* field as required.

5. Set the *Auto store point* check box as required.

The precision fields contain the manufacturer's precision values for the laser. They are for information only. Tap .

Magnetic Declination

Most lasers have a magnetic compass. Make sure that this compass is calibrated before taking any measurements.

When you enter a value for magnetic declination in the Trimble Survey Controller software, it is applied to all subsequent laser measurements.

To enter a value for magnetic declination:

1. Select *Configuration / Job / Cogo settings*.
2. Enter a value in the *Magnetic declination* field.

For more information about magnetic declination, see page 65.



Warning – If you enter a value for magnetic declination in the Trimble Survey Controller software, make sure that no magnetic declination value is set in the laser.

Vertical Angle Display

The laser measurements can be displayed as vertical angles measured from the zenith or inclinations measured from horizontal. Select a display option in the *Laser VA display* field in the *Units* screen. For more information, see System Units, page 58.

Configuring the Laser

Before using the laser with the TSCe data collector, configure the laser options. Table 23.1 shows the configuration for each laser that is supported by the Trimble Survey Controller software.

Table 23.1 Laser Settings

Laser	Laser setting
LTI Criterion 300 or LTI Criterion 400	From the main menu, press the down arrow or up arrow key until the <i>Survey</i> menu appears, then press <input type="button" value="Enter"/> . Select <i>Basic measurements</i> and press <input type="button" value="Enter"/> . A screen showing the fields <i>HD</i> and <i>AZ</i> appears.
LTI Impulse	Set up the laser to operate in CR 400D format. Make sure that a small <i>d</i> is displayed on the screen. (If necessary, press the Fire2 button on the laser).
Laser Atlanta Advantage	Set the <i>Range/Mode</i> option to <i>Standard (Averaged)</i> and the <i>Serial/Format</i> option to <i>Trimble Pro XL</i> .
Leica Disto memo/pro	Set the unit to meters or feet, not feet and inches.
MDL Generation II	No special settings are required.
MDL LaserAce	Set the <i>Data record</i> format to <i>Mode 1</i> . When using the angle encoder, set the magnetic declination to zero in the Trimble Survey Controller software. The angle encoder in the LaserAce corrects for the magnetic declination.

Note – You must configure the laser rangefinder to update the inclinometer and slope distance readings after each measurement.

Taking a Measurement with the Laser Rangefinder

To measure a point with the laser rangefinder:

1. Configure the survey style that you intend to use.

Note – If the Measure laser points option does not appear in the Survey menu, specify the laser type you are using in the Laser rangefinder type field in the survey style.
2. Connect the laser to the TSCe data collector.
3. Make sure that the laser is set up to take azimuth and distance measurements, and inclination (the last is optional).
4. From the Trimble Survey Controller main menu, choose *Survey*. Highlight the required survey style and tap **Enter**.
5. Select *Measure laser points*.
6. Enter a value in the following fields:
 - Point name.
 - Code (if required).
 - Start point – enter the name of the point that laser measurements are to be taken from.
 - Laser height (if required).
 - Target height (if required).
7. Occupy the start point with the laser and tap **Laser**. Follow the instructions on the TSCe data collector display screen.

Wait for the laser compass to settle before taking a measurement.

If the *Auto measure* field in the survey style *Laser Rangefinder* option is set to *Yes*, the Trimble Survey Controller software instructs the laser to take a measurement when you tap **Laser**. The Trimble Survey Controller software displays this measurement when it receives it.



Tip – You can take a measurement on the laser without tapping **Measure** first. The laser measurement is displayed on the screen of the TSCe data collector when the data is received.

If the Trimble Survey Controller software receives only a distance measurement from the laser, another screen is displayed with the measured distance in a *Slope distance* field. Enter a vertical angle if the measured distance was not horizontal.

8. Tap **Store** to store the point.

Note – If you are using a laser without a compass, you must key in a magnetic azimuth before the Trimble Survey Controller software can store the point.

Laser Softkey

In most *H. Dist* (horizontal distance) fields and *S. Dist* (slope distance) fields in the Trimble Survey Controller software, there is a **Laser** softkey. Use it to measure a distance with the laser and insert that value in the *H. Dist* field.

This function is useful when calculating an offset or intersection point.

To use the laser in the *H. Dist* field:

1. Configure the laser in the survey style that you intend to use, and start the survey in that style.
2. Access the *H. Dist* field and tap **Laser**. Follow the instructions on the screen.
3. When the Trimble Survey Controller software receives the measurement, it inserts the horizontal distance into the *H. Dist* field.

The TSCe Data Collector

In this chapter:

- Introduction
- Power source
- Operating the TSCe data collector
- Caring for the unit

Introduction

The Trimble Survey Controller software is designed to run on the TSCe data collector. This Appendix introduces the hardware and describes how to use it.

Figure A.1 shows a front view of the TSCe data collector and its main keys.

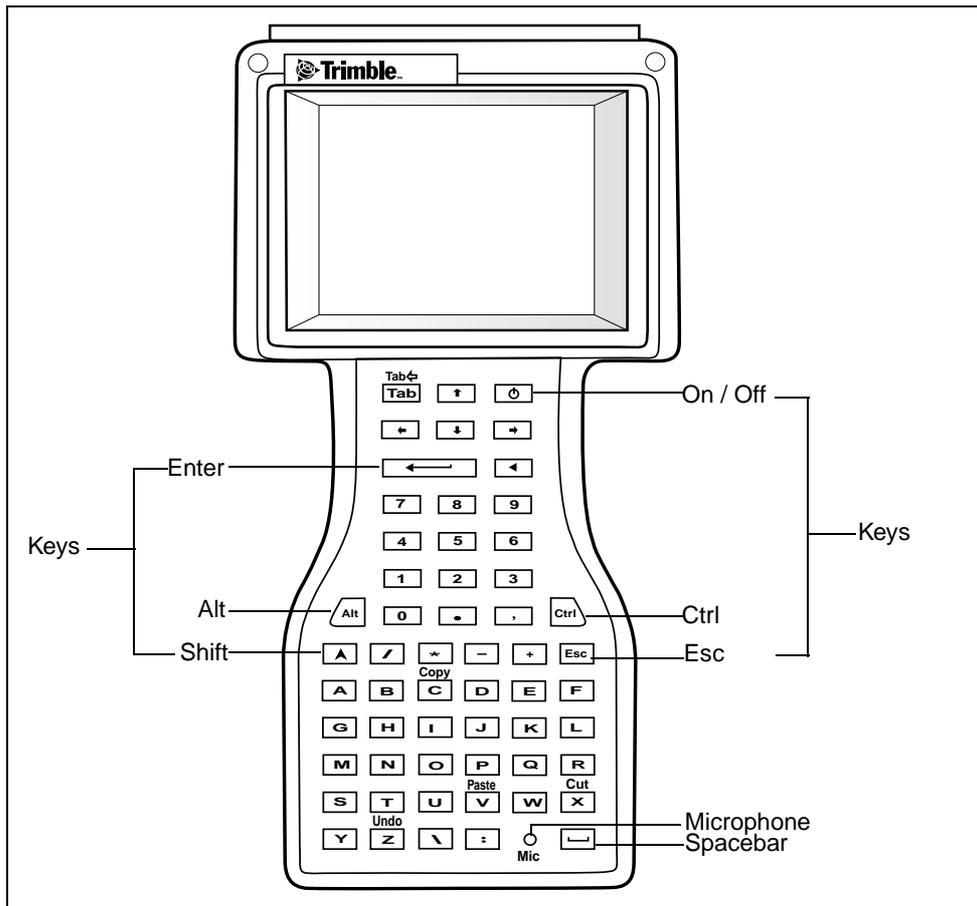


Figure A.1 The TSCe data collector – front view

The following keys perform these functions:

- Enter – activates the selected item
- Control (Ctrl) – activates the functions in purple above the keys
- Shift – activates the functions in yellow above the keys
- Escape – cancels the current task

Figure A.2 shows a top view of the TSCe data collector.

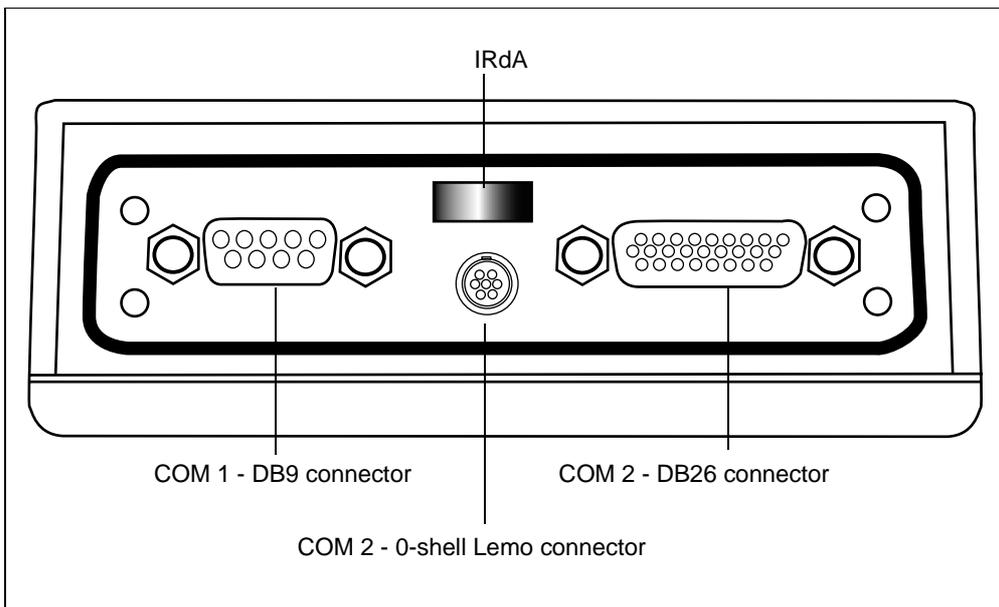


Figure A.2 The TSCe data collector – top view

Shortcut Keys

A shortcut key is a key combination that you can press to carry out a command without first selecting from a menu. See Table A.1.

Table A.1 Shortcut keys

Command	Shortcut key combination
Display contrast	 +  or  + 
Windows Start menu	 + 
Windows CE Task Manager	 + 
Touch Screen Calibration	 +  + 
Delete files in Explorer	 + 
Copy	 + 
Paste	 + 
Switch between programs	 +  or  + 

Power Source

The TSCe data collector is supplied with a rechargeable 4.8 volt, 3800mAh NiMH battery. This battery provides over 30 hours of use per charge.

Installing the Battery

To install the battery:

1. Remove the handstrap from the battery door.
2. Use a screwdriver to completely loosen the four screws on the backcase.
3. Connect the battery to the white plug in the case. It will only connect one way.

4. Insert the battery into the battery compartment. Tuck the wires to the left to prevent them from becoming pinched.
5. Replace the backcase and tighten the four screws firmly.

Charging the Battery

The TSCe data collector incorporates a quick circuit that recharges the NiMH battery to 90% capacity in approximately 1 hour.

To recharge the battery, connect the TSCe to the AC adapter using the RS232 power supply Y-cable.

The TSCe data collector should turn on and start the initial boot process. Recharge the TSCe data collector for a minimum of two hours before using it on battery power alone.

The TSCe data collector remains on to monitor the battery while it is charging. To turn off the display, press the  key.

Note – You cannot connect the TSCe data collector through the Office Support Module II for charging.

Changing the Battery

Contact your local dealer for a replacement battery.

When changing the battery, close all applications and save the data. Resetting a unit or changing the batteries has no effect on stored data or flash memory.

Operating the TSCe Data Collector

This section describes how to operate the features of the TSCe data collector.

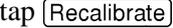
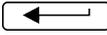
Screen

The TSCe data collector has a reflective LCD screen that can be viewed in direct sunlight. The screen incorporates highly reflective mirrors behind the display that make it bright and easy to read, even in overcast conditions.

The screen also incorporates a passive touch interface. This lets you navigate around the system by touching elements on the display screen with a stylus or your finger.

Calibrating the touch screen

If the touch screen is not responding properly to taps, you may need to calibrate the touch screen. To start the calibration procedure:

1. Do one of the following:
 - Press  +  + .
 - Tap  and select *Settings / Control Panel / Stylus*. The *Stylus Properties* dialog appears. From the *Calibration* tab, tap .
2. Follow the on screen prompts by tapping the target as it moves from the center of the screen to each corner. If the calibration fails, repeat the procedure.
3. If the calibration is successful, press  to accept the new settings. Press  to keep the old settings.

Adjusting the double-tap speed

To adjust the stylus double-tap speed:

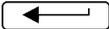
1. Tap  and select *Settings / Control Panel / Stylus*.
The *Stylus Properties* dialog appears.
2. From the *Double-Tap* tab, double-tap the checkerboard grid to set the speed at which software applications will recognize your double-taps.



Tip – Double-tap the clipboard icon to test your settings. If the icon does not change, adjust your setting again.

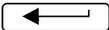
Movement on the screen

To move around the screen, do one of the following:

- Use the cursor keys and press .
- Use the stylus or your finger to tap or double-tap .
- To move a screen object, press the stylus or your finger on the object, while dragging across the screen.

Setting the Clock

To change the TSCe data collector time and date settings:

1. Do one of the following:
 - Double-tap on the clock located on the right side of the taskbar.
 - Tap  and select *Settings / Control Panel / Date/Time*.
The *Date/Time Properties* dialog appears.
2. Change the date and time as required. Press  to accept the new settings or  to cancel.

Note – When you connect the TSCe data collector to the GPS receiver, the date and time are updated.

Adding an Item to the Desktop

To add a program to the computer desktop:

1. Double-tap *My Computer*.
2. Select the file or program to be added to the desktop, then tap *File / Send To / Desktop as Shortcut*.

Storage Card

The TSCe data collector has a built-in storage card that may be used to store your data and programs. This appears in the Windows CE files system as the \Disk folder. Windows CE system maintains several special files on this card, such as nk.bin and ranger.reg. The files contain crucial information necessary for the correct operation of the TSCe data collector. Directly modifying these files may result in the TSCe data collector failing to operate correctly.

Rebooting

If the TSCe data collector fails to respond to keystrokes, you may need to reboot the system. Turn off the data collector and turn it back on again.

If this does not work then perform a soft reset.

Soft reset

A soft reset (warm boot) shuts down the hardware and restarts the Trimble Survey Controller software. You will not lose any data by performing a warm boot.

To perform a soft reset:

- Hold down  and , while you press and release .

The TSCe data collector will reset to the default Microsoft Windows desktop view.

Hard reset

You will not lose any data that is stored on the built-in storage card (the \Disk folder) by performing a hard reset (cold boot). The contents of the RAM memory will be cleared, including any desktop shortcuts that you have created.

To perform a hard reset:

1. Hold down .

After approximately 5 seconds, a dialog and a countdown timer appear, indicating that the TSCe data collector will reset.

2. Continue to hold  for 5 seconds, then release.

The TSCe data collector will briefly display the boot screen and then reset to the default Microsoft Windows desktop view.

Caring for the Unit

Trimble recommends the following to maintain your TSCe data collector during everyday use, as well as preventing potential physical damage or data loss.

Temperature

Do not expose the unit to temperatures below -20 C (-4°F) or above $+60\text{ C}$ (140°F). Do not leave it in direct sunlight for extended periods of time.

Shock

The unit is designed to withstand a MIL-STD-810E drop. However, impact or pressure on the display screen can cause it to crack. Protect the display from impact, pressure, or abrasive substances.

Water

The TSCe is designed to be immersible in up to one meter of water, for up to one hour. Ensure that the battery compartment screws are secured tightly when replacing the battery.

Note – Removal of the backcase screws voids the warranty.

Cleaning the case

Clean the unit with a soft cloth dampened with clean water or with water containing a mild detergent. If the keyboard has dirt or grime on it, use compressed air or a vacuum cleaner, or gently rinse it with clean water.

Care of touch screen

Keep the touch screen clean using a soft cloth dampened with clean water or glass cleaner. Do not apply any cleaner directly to the screen—apply the cleaner to the soft cloth and then gently wipe the screen.

Note – Do not use any abrasive cleaners.

Applying a screen protector

Use a screen protector to help keep the touch screen clean and protected. Clean the screen thoroughly and leave it slightly wet. Peel the backing from the screen protector before applying it to the screen. Use a soft cloth to squeeze the excess water and air from under the screen protector.

Safeguarding data

Back up your work regularly using Microsoft ActiveSync or the Trimble Data Transfer utility.

ESD protection

All computers are susceptible to electrostatic discharges. Before using the TSCe data collector, discharge any built-up static by grounding yourself to a non-electronic item.

Display heater

Use the display heater by plugging in an external 12-volt battery. If the internal temperature drops below 0°C (32°F), the heater will automatically turn on to warm the unit.

Database Search Rules

In this chapter:

- Introduction
- The Trimble Survey Controller database
- Database search rules

Introduction

This appendix discusses the database search rules that are used by the Trimble Survey Controller software.

The Trimble Survey Controller Database

The Trimble Survey Controller software includes a dynamic database. This stores networks of connected vectors during RTK and conventional surveys, making the positions of some points dependent on the positions of others. If you change the coordinates of a point that has dependent vectors (for example, an instrument station, a backsight point, or a GPS base station), this affects the coordinates of all points that depend on it.

To change the coordinates of a point, do one of the following:

- Measure another point with the same name as the existing point. When the Duplicate point, out of tolerance warning appears, select *Overwrite*.
- Key in another point with the same name as the existing point. When Duplicate point, out of tolerance warning appears, select *Overwrite*.

Note – This warning only appears if the new point is out of tolerance with the original point. If you have changed the tolerance values the message may not appear. For more information, see *Duplicate point: Out of tolerance screen*, page 212.

The Trimble Survey Controller software uses database search rules to resolve the coordinates of dependent points, based on the new coordinates for a point they depend on. If the coordinates of a point with dependent points move by a certain amount, the dependent points are shifted by the same amount.

If a point name already exists in the database, the Trimble Survey Controller software displays the Duplicate point, out of tolerance warning message when you try to store a point that is outside the duplicate point tolerance, and that has the same name. The exception to this is when you store a face 2 observation to a point that already has a face 1 observation—in this case the face 2 observation is checked to see if it is within tolerance of the face 1 observation and then stored. For more information about face 1 and face 2 observations, see *Measuring a Point in Two Faces*, page 364.



Warning – When you get the duplicate point warning, you could be about to overwrite a point that has dependent vectors. The coordinates of the dependent vectors could change.

Database Search Rules

This section explains the database search rules relevant to the Trimble Survey Controller database.

The Trimble Survey Controller software lets multiple points with the same point name (point ID) exist in the same job:

- If you measure or key in a point with a name that already exists in the database, you can choose to overwrite it when you store the new one. All previous points of the same name, and with the same or a lower search class, are deleted.

***Note** – Deleted points remain in the database and have a search class of Deleted. For more information, see *Search Class*, page 425.*

- If you measure or key in a point with a name that already exists in the database, you can choose to store another point. Both points are stored in the database, and both are transferred with the job. The Trimble Survey Controller search rules ensure that the point with the highest class is used for calculations. If there are two points of the same class, the **first** is used.

To distinguish between points of the same name and to decide how these points are to be used, the Trimble Survey Controller software applies a set of search rules. When you ask for the coordinates of a point in order to perform a function or calculation, these search rules sort the database according to:

- the order in which the point records were written to the database
- the classification (search class) given to each point

Order in the Database

A database search starts at the beginning of the job database and works down to the end of the job, looking for a point with the specified name.

The Trimble Survey Controller software finds the first occurrence of a point of that name. It then searches the rest of the database for points of the same name.

Note – The database search changed for version 7.50 and later of the Trimble Survey Controller software. Previously the software searched from the end of the job database and worked up.

The rules generally followed by the software are:

- If two or more points have the same class and the same name, it uses the first point.
- If two or more points have the same name but different classes, it uses the point of higher class, even if this is not the first occurrence of the point.
- If two or more points—one from the job database and one from an attached .csv file—have the same name, the one in the job database is used.

Search Class

The Trimble Survey Controller software gives most points a classification. It uses this classification to determine the relative importance of points stored in the job database.

Note – Matched pair and mean turned angle records do not have a classification because they are exceptions to the search rules. For more information, see *Exceptions to the search rules*, page 428.

The classes are arranged in a descending hierarchy, as follows:

- Control – (the highest class) can only be set when a point is keyed in or transferred. This classification is also given to points that are adjusted in a traverse computation.
- Normal – is given to all measured points apart from staked points. Transferred points can also be given this class.
- As-staked – is given to points measured during stakeout.
- Backsight – is given to observations made to the backsight point during a station setup and to observations made during a resection.
- Check – is given to a conventional check point observation, or a GPS point measured with a duplicate name and stored as a Check class point. For more information, see *Duplicate point: Out of tolerance screen*, page 212.
- Deleted – is given to points that have been overwritten, where the original point had the same (or a lower) search class than the new point. It is also given to points/lines/arcs and roads that were deleted manually in the job database.

Deleted points are not displayed in point lists and they are not used in calculations. However, they do remain in the database.

Note – You cannot overwrite a control class point with a measured point.

Control class is used in preference to normal, as-staked, backsight, or check class. It can only be set by you. Use control class for points that you want to use in preference to points of the same name in the same job database. For more information, see Assigning control class to a point, page 427.

Normal class is used in preference to as-staked, backsight, or check class, and as-staked class is used in preference to backsight or check class.

If points have the same class as well as the same name, the first point in the database is used.

Example

If a point named “1000” is entered as the start point when calculating a from-a-baseline offset, the Trimble Survey Controller software searches for the first occurrence of point “1000”. It then searches the rest of the database for any point named “1000”, under the following rules:

- If no other point of this name is found, it uses the one it has to calculate the offset.
- If another point “1000” is found, the software compares the classes of the two points. It uses the point “1000” that has the highest classification.

For example, if both points were keyed in and one was given a normal classification, the other a control classification, the Trimble Survey Controller software uses the control class point to calculate the offset—regardless of which record the search finds first.

- If the points are of the same class, the Trimble Survey Controller software uses the first one.

For example, if both points named “1000” were keyed in, and both were given a normal classification, the first one is used.

Assigning control class to a point

Control class is the highest classification that you can give to a point. Any high-accuracy point that you use as a fixed standard in a job can be a control point.

If you specify control search class when you key in the coordinates for a point, you can be sure that those coordinates will not change until you key in another point of the same name and the same search class (control) and choose to overwrite the first point.

The Trimble Survey Controller software never elevates measured points to control class. This is because measured points have measurement errors and may change or be measured again during the course of the job. If the keyed-in point “CONTROL29” is control class, generally you would not want the coordinates of that point to change. A control class point is held fixed for the job.

The Trimble Survey Controller software can measure control points—observed control points—but it does not give them control classification. This is because, in calibration, the measured point often has the same name as the keyed-in control point. This makes it easier to set up the calibration. It also makes it easier to manage your data, for example, if you know that all references to point “CONTROL29” on the ground are also references to point “CONTROL29” in the database.

Exceptions to the search rules

Normal search rules are not used in the following situations:

- In calibration – Calibration searches for the highest class point stored as grid coordinates. This grid point is used as one of a pair of calibration points. The Trimble Survey Controller software then searches for the highest class GPS point stored as WGS-84 coordinates or as a WGS-84 vector. This point is used as the GPS part of the point pair.
- When starting an RTK rover – When you start a rover survey, if the broadcast base point is called “BASE001”, choosing *Start survey* causes the Trimble Survey Controller software to search for the highest class GPS (WGS-84) point of that name. If no GPS point exists with the name “BASE001”, but “BASE001” exists with grid or local coordinates, the Trimble Survey Controller software converts the grid or local coordinates of the point into a GPS (WGS-84) point. It uses the projection, datum transformation, and current calibration to calculate the point. It is then stored, as “BASE001”, with WGS-84 coordinates and is given a check class classification so that the original grid or local coordinates will still be used in calculations.

Note – The WGS-84 coordinates of the base point in the Trimble Survey Controller database are the coordinates from which GPS vectors are solved.

If there is no base point in the database, the position broadcast by the base receiver is stored as a normal class point and it is used as the base coordinates.

- When using mean turned angle records – Mean turned angle records in the database are normal class points, and a control class point is always used in preference. However, a mean turned angle record is always used in preference to any other face 1 or face 2 observation, or matched pair record. If there are two mean turned angle records of the same name in the database, the first one is used.

***Note** – Matched pair records are not used by the Trimble Survey Controller search rules. A mean turned angle record always exists when there is a matched pair record and the mean turned angle record is always used in preference.*

- In a conventional survey, when the orientation is derived from a keyed-in azimuth and is later updated by providing coordinates for the backsight – In a conventional survey, when the coordinates for the backsight point are not known, the orientation for a station setup can be defined in the following ways:
 - An azimuth can be keyed in.
 - The azimuth can be left as null.

A keyed-in azimuth is always used in preference to a computed azimuth. To force the Trimble Survey Controller software to use a computed azimuth, edit the keyed-in azimuth and set it to null.

- In a conventional survey with angles-only observations – In a conventional survey an angles-only point has a lower search class than any other point of the same class.

***Note** – Points in a .csv file that are automatically copied to the job database are stored as normal class points, so follow the standard search class rules for normal points. CSV points that are accessed by a job, but are not copied to the job database, do not follow the database search rules.*

Conventional Instrument Settings

In this chapter:

- Introduction
- Trimble and Geodimeter
- Leica
- Sokkia
- Nikon
- Pentax
- Additional notes

Introduction

This appendix lists the settings for different conventional instruments. The Trimble Survey Controller software supports the instruments listed and other instruments that are compatible.

Trimble and Geodimeter

- Before you connect the TSCe data collector to older Geodimeter instruments, select an appropriate survey style, which must specify the correct type of instrument. Connect the instrument and select *Station setup*. Failure to follow this procedure may result in communication errors. If this occurs, turn the instrument off and try again.

This does not apply to robotic instruments connected remotely through a radio modem.

- To use the Trimble Survey Controller software with a Geodimeter 600 instrument in robotic mode, you must have the third-party interface option (C&C) turned on in the instrument.

All Trimble 5600 and Geodimeter 600 instruments shipped since November 2000 have the option already installed. To get the option installed, or if you are unsure if the option is installed in your instrument, please check with your local distributor or service center.

- When you measure a point using a Geodimeter 420 instrument, press A/M on the instrument then **Measure** in the Trimble Survey Controller software.

Robotic instrument radio support

To configure the radio settings for a Trimble 5600 Series and a Geodimeter System 600 Robotic instrument from the Trimble Survey Controller software:

1. Configure the *Radio channel*, *Station address* and *Remote address* fields as required in the *Instrument* menu of your survey style.
2. Remove the CU600 control unit from the instrument, connect the TSCe data collector, and turn the instrument on.
3. Tap the  softkey to set the radio at the instrument.

When you connect the TSCe data collector to the remote radio, the Trimble Survey Controller software establishes the radio link between the instrument and remote radio using the specified settings.

Leica

- Before you connect the TSCe data collector to a Leica instrument, select an appropriate survey style, which must specify the correct type of instrument. Connect the instrument and select *Station setup*. Failure to follow this procedure may result in communication errors. If this occurs, turn the instrument off and try again.

This does not apply to robotic instruments connected remotely through a radio modem.

- When using a Leica instrument in reflectorless mode, set the EDM precision to *Instr: default* in the survey style.

Sokkia

- The *Stakeout turn to zero* check box appears when the instrument type is SET (Extended). Select this check box if you want the horizontal angle on the instrument to display 0° 00' 00" when the instrument is turned on line with the point in stakeout.

Nikon

- The Nikon cable looks identical to the Topcon and Sokkia cables, but the pin outputs are different. These cables are not interchangeable.
- Most Nikon instruments support the Set (Basic) commands, so in addition to using the Nikon instrument type you can also specify Set (Basic) as the instrument in the survey style for use with Nikon instruments.

Pentax

- Do not use the *Mils*, or *Feet/inches* units when using a Pentax instrument.

Additional Notes

- The conventional instrument should always display the *Measure* screen when connected to the Trimble Survey Controller software. Some instruments (for example, the Leica) cannot communicate to external devices when they are not in the measure screen.
- The Trimble Survey Controller software automatically sets the data bits based on the parity. When the parity is *None*, *Data bits* is set to 8. When the parity is *Odd or Even*, *Data bits* is set to 7.

For additional information on using a conventional instrument with the Trimble Survey Controller software, see the *Trimble Survey Controller Release Notes*.

If you are using an instrument that is not listed, try using the survey style for a similar instrument, and configure the appropriate settings on the instrument, as shown in Table C.1.

Table C.1 Conventional instrument settings

Make and model	Trimble Survey Controller default communication settings	Cable connected to TSCe	Conventional instrument setting
Trimble			
3300	Baud: 9600 Parity: None HA VA status rate: 1 s	8P connector to DB9	Set the protocol to REC E and turn off recording.
3600			The Rec Elta Protocol Interpreter software is required on the instrument.
600M	Baud: 1200 Parity: None HA VA status rate: Never	Hirose to 0-shell Lemo (Trimble p/n 44147) Hirose Y-cable with power supply to 0-shell Lemo Hirose to DB9	Select the Standard table (table number 0). Set F79 to 62.
5600 Servo	Baud: 9600 Parity: None HA VA Status Rate: 2 s		Select the Standard table (table number 0). Select RPU Manual or Automatic.
5600 Robotic			Select the Standard table (table number 0). Select RPU Remote.
TTS 300/500	Baud: 9600 Parity: None HA VA Status Rate: 1 s	0-shell Lemo to 0-shell Lemo (Trimble p/n 31288)	No special settings.

Table C.1 Conventional instrument settings (Continued)

Make and model	Trimble Survey Controller default communication settings	Cable connected to TSCe	Conventional instrument setting		
Leica					
TC300	Baud: 19200 Parity: Even HA VA status rate: 2 s	Leica 5-pin Lemo to DB9	No special settings.		
TC500	Baud: 2400 Parity: Even				
TC800	HA VA status rate: 2 s				
TC805					
T1000 (6 key model)	Baud: 2400 Parity: Even HA VA status rate: Never		Leica 5-pin Lemo to DB9	Set the instrument communications format to T1000 and output to GRE.	
T1000 (14 key model)	Baud: 2400 Parity: Even				
TC1100	HA VA status rate: 2 s				
TC1100 Servo (GSI)	Baud: 9600 Parity: Even HA VA status rate: 2 s			Leica Y-Cable with power supply to DB9	Set the RCS communications mode to off. Ensure that the instrument is in Measurement mode.
TC1100 Servo (Geocom)	Baud: 19200 Parity: None				Set the RCS communications mode to on. Ensure that the instrument is in Measurement mode.
TC1100 Robotics (Geocom)	HA VA status rate: 2 s				
TC1600					
TC2000	Baud: 2400 Parity: Even HA VA status rate: 2 s	Leica 5-pin Lemo to DB9	No special settings.		
TC2002			On the instrument, select SET MODE, then 75.		
			No special settings.		

Table C.1 Conventional instrument settings (Continued)

Make and model	Trimble Survey Controller default communication settings	Cable connected to TSCe	Conventional instrument setting
Nikon			
DTM-310	Baud: 1200 Parity: None HA VA status rate: 2 s	Hirose to DB9	No special settings.
DTM-420			
DTM-450			
DTM-520			
DTM-530			
DTM-800	Baud: 1200 Parity: None HA VA status rate: Never		Use Instrument type Set (Basic). The DTM-800 does not support the Nikon format.
Pentax			
PCS-325	Baud: 1200 Parity: None HA VA status rate: 1 s	Hirose to DB9	Configure the port parameters as follows: Xon/Xoff: No Command set: Nil
Sokkia			
SET 3B	Baud: 1200 Parity: None HA VA status rate: Never	Hirose to DB9	When using Set (Extended) select RS232C on the SET and set the Checksum to No. No special settings required using SET (Basic).
SET 3C II			
SET 5W			
SET 5F			
Power set 3100			

Table C.1 Conventional instrument settings (Continued)

Make and model	Trimble Survey Controller default communication settings	Cable connected to TSCe	Conventional instrument setting
Spectra Precision (Geotronics)			
420	Baud: 1200 Parity: Even HA VA status rate: Never	Geotronics DB9 Y-cable with power supply to DB9	Select the Standard table (table number 0). Set F79 to 62.
520	Baud: 1200 Parity: None HA VA status rate: Never	Hirose to 0-shell Lemo (Trimble P/N 44147)	
610			
620			
640			
500/600 Servo	Baud: 9600 Parity: None HA VA Status Rate: 2 s	Hirose Y-cable with power supply to 0-shell Lemo	Select the Standard table (table number 0). Select RPU Manual or Automatic.
600 Robotics		Hirose to DB9	Select the Standard table (table number 0). Select RPU Remote.
4000 Servo	Baud: 9600 Parity: None HA VA Status Rate: Never	Geotronics DB9 Y-cable with power supply to DB9	Select the Standard table (table number 0). Set F79 to 62.

Table C.1 Conventional instrument settings (Continued)

Make and model	Trimble Survey Controller default communication settings	Cable connected to TSCe	Conventional instrument setting
Topcon			
GTS-700	Baud: 1200 Parity: Even HA VA status rate: Never	Hirose to DB9	No special settings.
GTS-701			
GTS-711D			
GTS-500			
GMT-100			Select Parameters / Comms and set the CR/LF option to OFF. Turn off the minimum distance setting.
GTS-311			Select Parameters / Comms and set the CR/LF option to OFF.
GTS-312			
GTS-211D			No special settings.
Zeiss			
Elta 2	Baud: 1200	Zeiss 5P connector to DB9	No special settings.
Elta 3	Parity: Odd		
Elta 4	HA VA status rate: Never		
Rec Elta 15	Baud: 4800 Parity: Odd HA VA status rate: 1 s	Zeiss 8P connector to DB9	Do not use Mils as the angular units.
Elta C	Baud: 9600 Parity: None HA VA status rate: 1 s		Set data record format to Rec 500.
R Series	Baud: 9600 Parity: None HA VA status rate: 1 s		The Rec Elta Protocol Interpreter software is required on the instrument.
S Series	Not supported		Set the protocol to REC E and turn off recording.

Glossary

This section explains some of the terms used in this manual.

almanac	Data, transmitted by a GPS satellite, that includes orbit information on all the satellites, clock correction, and atmospheric delay parameters. The almanac facilitates rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced precision.
Anti-Spoofing (AS)	A feature that allows the U.S. Department of Defense to transmit an encrypted Y-code in place of P-code. Y-code is intended to be useful only to authorized (primarily military) users. Anti-Spoofing is used with Selective Availability to deny the full precision of GPS to civilian users.
autonomous positioning	The least precise form of positioning that a GPS receiver can produce. The position fix is calculated by one receiver from satellite data alone.
base station	<p>In a GPS survey, you observe and compute baselines (the position of one receiver relative to another). The base station acts as the position from which all unknown positions are derived.</p> <p>A base station is an antenna and receiver set up on a known location specifically to collect data to be used in differentially correcting rover files. Trimble GPS Community Base Station and a receiver in base station mode are examples of base stations.</p>

baud	A unit of data transfer speed (from one binary digital device to another) used in describing serial communications; generally one bit per second.
C/A code	See Coarse Acquisition code.
CMR	Compact Measurement Record. A satellite measurement message that is broadcast by the base receiver and used by RTK surveys to calculate an accurate baseline vector from the base to the rover.
Coarse Acquisition (C/A) code	A pseudorandom noise (PRN) code modulated onto an L1 signal. This code helps the receiver compute the distance from the satellite.
constellation	<p>A specific set of satellites used in calculating positions: three satellites for 2D fixes, four satellites for 3D fixes.</p> <p>All satellites visible to a GPS receiver at one time. The optimum constellation is the constellation with the lowest PDOP. See also PDOP.</p>
data logging	The process of recording satellite data in a file stored in the receiver or the datalogger memory.
data message	A message, included in the GPS signal, that reports on the location and health of the satellites as well as any clock correction. It includes information about the health of other satellites as well as their approximate position.
datum	See geodetic datum.
Differential Positioning	Precise measurement of the relative position of two receivers tracking the same satellites simultaneously.

DOP	<p>Dilution of Precision, an indicator of the quality of a GPS position. DOP takes into account the location of each satellite relative to other satellites in the constellation, as well as their geometry relative to the GPS receiver. A low DOP value indicates a higher probability of accuracy.</p> <p>Standard DOPs for GPS applications are:</p> <ul style="list-style-type: none">– PDOP – Position (three coordinates)– RDOP – Relative (Position, averaged over time)– HDOP – Horizontal (two horizontal coordinates)– VDOP – Vertical (height only)– TDOP – Time (clock offset only)
Doppler shift	<p>The apparent change in frequency of a signal caused by the relative motion of satellites and the receiver.</p>
DTM	<p>Digital Terrain Model. An electronic representation of terrain in three dimensions.</p>
dual-frequency	<p>A type of receiver that uses both L1 and L2 signals from GPS satellites. A dual-frequency receiver can compute more precise position fixes over longer distances and under more adverse conditions because it compensates for ionospheric delays.</p>
Earth-Centered-Earth-Fixed (ECEF)	<p>A cartesian coordinate system used by the WGS-84 reference frame. In this coordinate system, the center of the system is at the earth's center of mass. The z axis is coincident with the mean rotational axis of the earth and the x axis passes through 0° N and 0° E. The y axis is perpendicular to the plane of the x and z axes.</p>
elevation	<p>Height above mean sea level. Vertical distance above the geoid.</p>

elevation mask	The angle below which Trimble recommends that you do not track satellites. Normally set to 13 degrees to avoid interference from buildings and trees as well as ground multipath errors.
ellipsoid	A mathematical model of the earth formed by rotating an ellipse around its minor axis. For ellipsoids that model the earth, the minor axis is the polar axis and the major axis is the equatorial axis. An ellipsoid is completely defined by specifying the lengths of both axes, or by specifying the length of the major axis and the flattening.
ephemeris	The current satellite position predictions, transmitted in the data message.
epoch	The measurement interval of a GPS receiver. The epoch varies according to the survey type: <ul style="list-style-type: none">– for real-time surveys it is set at one second– for postprocessed surveys it can be set to a rate of between one second and one minute
feature codes	Simple descriptive words or abbreviations that describe the features of a point. For more information see Chapter 5, Using Feature and Attribute Libraries.
fixed solution	Indicates that the integer ambiguities have been resolved and a survey is initialized. This is the most precise type of solution.
float solution	Indicates that the integer ambiguities have not been resolved, and that the survey is not initialized.
GDOP	Geometric Dilution of Precision. The relationship between errors in user position and time, and errors in satellite range. See also DOP.

geodetic datum	<p>A mathematical model designed to fit part or all of the geoid (the physical earth's surface). A geodetic datum is defined by the relationship between an ellipsoid and the center of the earth. It takes into account the size and shape of the ellipsoid, and the location of the center of the ellipsoid with respect to the center of the earth (a point on the topographic surface established as the origin of the datum).</p> <p>Various datums have been established to suit particular regions. For example, European maps are often based upon the European datum of 1950 (ED-50). Maps of the United States are often based upon the North American Datum of 1927 or 1983 (NAD-27, NAD-83). All GPS coordinates are based upon the WGS-84 datum surface.</p>
geoid	<p>The surface of gravitational equipotential that closely approximates mean sea level.</p>
GPS	<p>Global Positioning System. Based on a constellation of 24 operational satellites orbiting the earth at a high altitude.</p>
GPS time	<p>A measure of time used by the NAVSTAR GPS system. GPS time is based on UTC but does not add periodic 'leap seconds' to correct for changes in the earth's period of rotation.</p>
HDOP	<p>Horizontal Dilution of Precision. See also DOP.</p>
integer ambiguity	<p>The whole number of cycles in a carrier phase pseudorange between the GPS satellite and the GPS receiver.</p>
ionosphere	<p>The band of charged particles 80 to 120 miles above the earth's surface. The ionosphere affects the accuracy of GPS measurements if you measure long baselines using single-frequency receivers.</p>

L1	The primary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1575.42 MHz. It is modulated by C/A code, P-code, or Y-code, and a 50 bit/second navigation message.
L2	The secondary L-band carrier used by GPS satellites to transmit satellite data. The frequency is 1227.6 MHz. It is modulated by P-code or Y-code, and a 50 bit/second navigation message.
local ellipsoid	The ellipsoid specified by a coordinate system. The WGS-84 coordinates are first transformed onto this ellipsoid, then converted to grid coordinates.
multipath	Interference, similar to ghosting on a television screen. Multipath occurs when GPS signals traverse different paths before arriving at the antenna. A signal that traverses a longer path yields a larger pseudorange estimate and increases the error. Reflections from structures near the antenna can cause the incidence of multiple paths to increase.
NAVDATA	The 1500-bit navigation message broadcast by each satellite. This message contains system time, clock correction parameters, ionospheric delay model parameters, and details of the satellite's ephemeris and health. The information is used to process GPS signals to obtain user position and velocity.
NMEA	A standard, established by the National Marine Electronics Association (NMEA), that defines electrical signals, data transmission protocol, timing, and sentence formats for communicating navigation data between marine navigation instruments.
parity	A form of error checking used in binary digital data storage and transfer. Options for parity checking include Even, Odd, or None.

P-code	The 'precise' code transmitted by the GPS satellites. Each satellite has a unique code that is modulated onto both the L1 and L2 carrier waves. The P-code is replaced by a Y-code when Anti-Spoofing is active.
PDOP	Position Dilution of Precision, a unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, PDOP is proportional to 1 divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. Values considered good for positioning are small (for example, 3). Values greater than 7 are considered poor. Small PDOP is associated with widely separated satellites. PDOP is related to horizontal and vertical DOP by $PDOP^2 = HDOP^2 + VDOP^2$. See also DOP .
PDOP mask	The highest PDOP value at which a receiver will compute positions.
postprocess	To process satellite data on a computer after it has been collected.
PRN	<p>Pseudorandom number, a sequence of digital 1's and 0's that appear to be randomly distributed like noise, but that can be exactly reproduced. PRN codes have a low autocorrelation value for all delays or lags except when they are exactly coincident.</p> <p>Each NAVSTAR satellite can be identified by its unique C/A and P pseudorandom noise codes, so the term 'PRN' is sometimes used as another name for GPS satellite or SV.</p>
projection	Projections are used to create flat maps that represent the surface of the earth or parts of that surface.

QC records	Quality Control records. With precise positioning applications, this receiver option lets you process RTCM-104 corrections and satellite data in real time to provide position precision statistics.
ratio	During initialization, the receiver determines the integer number of wavelengths between each satellite and the GPS antenna phase center. For a particular set of integers, it works out the probability that this is the correct set. The receiver then calculates the ratio of the probability of correctness of the currently-best set of integers to the probability of correctness of the next-best set. A high ratio indicates that the best set of integers is much better than any other set. (This gives us confidence that it is correct.) The ratio must be above 5 for New Point and OTF initializations.
RDOP	Relative Dilution of Precision. See also DOP.
reference station	See base station .
RMS	Root Mean Square. This is used to express the accuracy of point measurement. It is the radius of the error circle within which approximately 70% of position fixes are to be found. It can be expressed in distance units or in wavelength cycles.
rover	Any mobile GPS receiver and field computer collecting data in the field. The position of a roving receiver can be differentially corrected relative to a stationary base GPS receiver.
RTCM	Radio Technical Commission for Maritime Services, a commission established to define a differential data link for the real-time differential correction of roving GPS receivers. There are two types of RTCM differential correction messages, but all Trimble GPS receivers use the newer Type 2 RTCM protocol.
RTK	Real-time kinematic, a type of GPS survey.

single-frequency	A type of receiver that only uses the L1 GPS signal. There is no compensation for ionospheric effects.
SNR	Signal-to-Noise Ratio, a measure of the strength of a satellite signal. SNR ranges from 0 (no signal) to around 35.
SV	Satellite Vehicle (or Space Vehicle).
TDOP	Time Dilution of Precision. See also DOP.
TOW	Time of Week in seconds, from midnight Saturday night/Sunday morning GPS time.
tracking	The process of receiving and recognizing signals from a satellite.
UTC	Universal Time Coordinated. A time standard based on local solar mean time at the Greenwich meridian. See also GPS time.
VDOP	Vertical Dilution of Precision. See also DOP.
WAAS	Wide Area Augmentation System. A satellite-based system that broadcasts GPS correction information. WAAS capable GPS receivers can track WAAS satellites. WAAS is synonymous with the European Geostationary Navigation Overlay Service (EGNOS) and Japan's Multifunctional Transport Satellite Space-based Augmentation System (MSAS).
WGS-84	World Geodetic System (1984), the mathematical ellipsoid used by GPS since January 1987. See also ellipsoid.
Y-code	An encrypted form of the information contained in the P-code. Satellites transmit Y-code in place of P-code when Anti-Spoofing is in effect.

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Symbols

.csv file. *See* Comma Delimited file
.dc file. *See* Data Collector file
.ggf file. *See* Geoid Grid file

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